UNDERSTANDING ATTITUDES TOWARDS AND PERCEPTIONS OF CONTROLLED ENVIRONMENT AGRICULTURE AMONG RURAL YOUNG ADULTS IN SOUTH AFRICA

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ABSTRACT

Food insecurity and chronic hunger are prevalent in South Africa, especially in marginalized rural communities. Environmental factors such as water scarcity and limited land availability make food production difficult for rural dwellers. At the same time, the youth unemployment rate in South Africa is more than 50%, negatively contributing to South Africa's economic development. Finding ways to engage youth in the economy is critical to advancing South Africa's development. While food production offers an avenue into economic activity, many young people have a negative perception of agriculture, viewing it as difficult, antiquated, and unlucrative. Controlled-environment agriculture (CEA), including hydroponics, aeroponics, and aquaponics, offers a potential solution to these issues. CEA uses water and space more efficiently than traditional growing methods, and may be more appealing to young people when compared to traditional agriculture. While CEA has the potential to address issues constraining food production and youth unemployment in South Africa, little research has been done to measure young people's attitudes and perceptions regarding CEA.

This research project will focus on measuring the attitudes and perceptions young South Africans have towards traditional agriculture and CEA by conducting participant-led focus groups in three rural villages in the Limpopo Province of South Africa. Results suggest that young adults believe CEA has the potential to address some of the most pressing challenges constraining traditional agriculture in their communities. Specifically, they believe it has the potential to significantly reduce the amount of hard physical labor required to produce food, and to be financially rewarding. While participants responded positively to the concept of CEA, they also acknowledged that it comes with its own set of challenges, which would need to be addressed before CEA operations could be successful. Specifically, participants were concerned

with CEA's need for specialized skills and startup capital. If these challenges could be addressed, they believe investment in CEA-centered development initiatives could positively impact their communities.

INTRODUCTION

Food insecurity and chronic hunger are prevalent in South Africa, especially in marginalized rural communities (Faber & Wenhold, 2007; Labadarios et al., 2008; Labadarios et al., 2011). Environmental factors such as water scarcity and limited land availability make food production difficult for rural dwellers (Blignaut et al., 2014; Consultative Group for International Agricultural Research, 2014; Pott, 2009; Vink, 2009; World Wildlife Fund, 2012) . Without access to locally available food in these communities, many people spend part of their limited income to pay for transportation to distant grocery stores, and are only able to buy the food they are able to carry home. At the same time, the youth unemployment rate in South Africa is more than 50%, economically depressing an entire generation and negatively contributing to South Africa's economic development (Development Policy Research Unit, 2012; Statistics South Africa, 2015; World Bank Development Indicators, 2016; Yu, 2013). Finding ways to engage youth in the economy is critical to advancing South Africa's development. While food production offers young South Africans a potential avenue into economic activity, many young people have a negative perception of traditional agriculture, viewing it as difficult, antiquated, and unlucrative (Food and Agriculture Organization, 2013; Nadeau et al., n.d.; Vargas-Lundius & Suttie, 2014).

Controlled-environment agriculture (CEA), including hydroponics[1], aeroponics[2], and aquaponics[3], offers a potential solution to these issues (du Plooy et al., 2012). These systems can recycle water in a closed-loop system, using up to 80% less water than traditional growing methods (Despommier, 2010). Vertical growing can be easily incorporated with CEA, meaning that it uses land more efficiently than traditional growing methods. Lastly, studies have shown that young people become more interested in agricultural endeavors when they are profitable and modern technology is incorporated (Agriculture for Impact, 2014; Brooks et al., 2013; Cassinath et al., 2016; Filmer et al., 2014; Food and Agriculture Organization, 2013; YouthPower, 2018). CEA offers larger, more stable yields, and produces harvests less time than traditional growing methods, meaning that producers can bring in more money in the same amount of time (Despommier, 2009).

While CEA has the potential to address issues constraining food production and youth unemployment in South Africa, little investment has been made in evaluating the effectiveness of potential CEA-centered interventions. While experts advocate for different approaches to international development, the majority agree on one key characteristic of successful interventions: listening to beneficiaries, understanding their thoughts and opinions, and putting them at the heart of the planning and implementation process (Easterly, 2007; Polok, 2008;

[1] Modern hydroponics was developed by William F. Gericke in 1929 and is a system of growing food without soil by suspending the plant's roots in water and manually adding all the nutrients the plant needs to grow.
[2] Aeroponics was developed by K.T. Hubick in 1982 and later improved by NASA scientists. In aeroponics, plants' roots are suspended in air and periodically sprayed with a nutrient-rich water solution. No soil is used.
[3] Aquaponics combines hydroponics with aquaculture, the practice of growing fish in controlled indoor environments. The waste from the fish becomes the nutrients that sustains plant growth, thus reducing or eliminating the need to manually add additional nutrients to water being used to grow the hydroponic plants.

Banerjee & Duflo, 2011; Consultative Group for International Agricultural Research, 2012) This research project takes the first step towards evaluating the effectiveness of potential CEA-centered interventions by trying to understand the attitudes and perceptions young people living in rural communities in the Limpopo Province of South Africa have towards CEA. More specifically, participant-led focus groups were facilitated to answer the following questions: What are young people's perceptions of and attitudes towards traditional agriculture? What are young people's perceptions of and attitudes towards CEA, and are they motivated to utilize CEA as a way to generate income? What local training/capacity building opportunities related to agriculture and/or entrepreneurship are young people aware of, and are they interested in taking part in these opportunities? By measuring youth buy-in, conclusions are drawn about the overall potential of investing in CEA as a way to combat youth unemployment and food insecurity in rural communities of the Limpopo province, allowing young people to earn an income while growing healthy, sustainable food for their communities using little land and water. Findings will be shared with other academics, as well as government agencies, funding agencies, and development organizations in an effort to help them make informed decisions about whether or not to invest in such a solution.

LITERATURE REVIEW

To develop a theoretical framework from which to approach this research project, it is important to understand the critical role that stakeholder buy-in and engagement play in the implementation of international development initiatives. It is also important to understand some of the related social, economic, and ecological challenges the country faces. South Africa is constrained by 1.) widespread food insecurity; 2.) high youth unemployment rates; 3.) water scarcity; and 4.) land scarcity. CEA offers a potential solution to these common challenges by using up to 80% less water than traditional growing methods, incorporating vertical growing which uses space more efficiently than traditional growing methods, and attracting youth to participate in the agriculture sector. This literature review will first explore the work of key development experts in order to develop a theoretical framework outlining the importance of stakeholder buy-in in development projects. It will then provide an overview of some of the challenges South Africa faces related to food production, followed by a discussion of why CEA provides a potential solution to these challenges.

Engaging Beneficiaries in Development

The past decade has seen a growing number of development experts calling for a radical re-thinking of the way we approach international aid. One of the most prominent voices calling for international aid reform has been that of William Easterly, Professor of Economics at New York University (NYU), Co-director of the NYU Development Research Institute, and author of *The Elusive Quest for Growth, The White Man's Burden,* and *The Tyranny of Experts.* Easterly contends that international aid has failed, and continues to fail, because the field is dominated by "Planners" - Western outsiders who design large-scale, top-down, one-size-fits-all solutions to eradicate global poverty - rather than "Searchers" - people who rely on understanding local

context, utilizing appropriate free-market incentives, and embracing trial and error to find the most effective ways to eradicate poverty on a case-by-case basis. Easterly describes the difference between Planners and Seekers like this:

> *A Planner thinks he already knows the answers; he thinks of poverty as a technical engineering problem that his answers will solve. A Searcher admits he doesn't know the answers in advance; he believes that poverty is a complicated tangle of political, social, historical, institutional, and technological factors. A Searcher hopes to find answers to individual problems only by trial and error experimentation. A Planner believes outsiders know enough to impose solutions. A Searcher believes only insiders have enough knowledge to find solutions, and that most solutions must be homegrown. (2007)*

To increase the effectiveness of international aid and decrease poverty, those working in the field of development need to become *seekers* willing to listen to 'insiders' and invest in homegrown solutions.

Paul Polak, Founder and CEO of Windhorse International and author of *Out of Poverty,* is also critical of traditional international development initiatives that focus on providing charity aid, building national economic growth, and building economies through big business interventions. He proposes that rigid top-down approaches designed by multilateral and development organizations are out of touch with the actual needs of the global poor because they do not take time to listen to the beneficiaries. He believes that charity aid and community-owned projects, as opposed to individually-owned market-driven solutions, often lead to a lack of buy-in and personal investment on the part of the stakeholders. Instead, he advocates for investing in smart market-driven interventions that allow the global poor to earn more money through their own efforts (2008).

Most recently, economists Abhijit Banerjee and Esther Duflo founded the Massachusetts Institute of Technology-based Abdul Latif Jameel Poverty Action Lab (J-PAL) and wrote *Poor Economics* in an effort to encourage "a radical rethinking of the way to fight global poverty"

(2011). Banerjee and Duflo suggest that sweeping generalizations about poverty and aid (e.g.: that all international aid is harmful or that global poverty can be eradicated with a drastic increase in aid dollars) are incorrect and ineffective. They believe that solutions to poverty must be context-specific and rigorously tested in order to determine the effectiveness of each individual intervention. They believe that listening to the poor and understanding the logic they use when making decisions is crucial to designing effective solutions to poverty. They advocate for Randomized Controlled Trials (RCTs), which measure the effectiveness of a particular program by comparing the outcomes of individuals, communities, and schools who receive a particular intervention to those who do not (Introduction to Evaluations, n.d.). Completed RCTs work together to create a patchwork of useful data that may help us understand and more accurately predict which aid programs will be most effective at addressing particular challenges (e.g.: preventing Malaria, improving school attendance, increasing farming yields, etc.) in various locations around the world.

Findings published by the Consortium of International Agricultural Research Centers (CGIAR) help shed light on what a successful agriculture-based project might look like in Limpopo, South Africa (CGIAR). From 2002-2013, CGIAR managed a global research program called the Challenge Program on Water and Food (CPWF) that conducted research in ten river basins around the world. The program had two primary goals: 1.) to "carry out research on innovative solutions for improving food production through better water management;" and 2.) to "test new approaches for conducting research-for- development" (Consortium of International Agricultural Research Centers, 2016). One of the ten basins selected as a research site was the Limpopo River Basin, where CPWF coordinated five research projects focused on water conservation. During this time, the CPWF conducted a Participatory Geographic Information

Systems (PGIS) data collection exercise in three districts that fall within the Limpopo River Basin. The main objective of this exercise was to identify successful agricultural water management interventions and to analyze what made these interventions successful. The study involved conducting interviews and focus groups with district-level stakeholders (government officials, local councils, NGOs, etc.) and local farmers and analyzing the data. The findings of the study are consistent with the recommendations of Easterly, Polok, Banerjee, and Duflo, concluding that projects are most successful when the beneficiaries are personally motivated to be involved and have an active voice in project planning and implementation (Consultative Group for International Agricultural Research, 2012).

While each expert is advocating for a slightly different approach to fighting global poverty, they all recommend one key element: putting the beneficiaries at the heart of defining problems, designing solutions, and implementing programs. Determining whether or not investment in CEA enterprises would successfully create jobs for rural young adults and/or increase food security in poorer rural communities in Limpopo, South Africa is a big question that would be best answered by designing and evaluating an RCT, or perhaps by designing a system prototype and testing its effectiveness through market-driven trial and error. Both of those options, however, require huge amounts of financial and human capital to undertake, and are outside the scope of this study. What this study aims to do instead is take an initial step towards determining the viability of such an intervention by listening to potential stakeholders, understanding their current perceptions of agriculture in their communities, and gauging their attitudes towards the introduction of CEA.

Historical Context

South Africa has endured a long history of racial injustice, resulting in inequalities and complex race relations today. Dutch settlers first colonized the Cape of Good Hope and established an economy favoring white settlers at the expense of native South Africans in 1652. This system continued for two centuries with little disturbance. Starting in the early 20th century, South Africa's colonial government began systematically dispossessing black South Africans of their land, forcing them to resettle in assigned areas known as "homelands." In the mid-20th century, while the rest of the world entered into various stages of decolonization, South Africa doubled down on its system of racial oppression.

The National Party government formally instituted *apartheid,* literally translated as "apartness" in Afrikaans, in 1948. Apartheid was the government-mandated practice of separating races in regards to where they lived, worked, and played. Black South Africans were not allowed to vote, live or work outside their assigned homelands without a government-issued pass, or share public spaces such as restrooms or swimming pools with whites. Apartheid "marked a real divide from what had gone before, not in general support for the separation of the races, but in the extent of such separation and in the means to be used to attain that separation" (Clark and Worger, 2016). While non-white South Africans began organizing against apartheid almost immediately, and other former colonies began fighting for racial justice in South Africa in the international sphere not long after, it wasn't until the 1980's when South Africa inched closer and closer towards a civil war that the rest of the international community began to take action. Overwhelming civil unrest and stringent international economic sanctions worked together and eventually forced South Africa's government to negotiate an end to apartheid and move towards a more democratic political system between the years 1990-1994 (Clark and Worger, 2016).

Although Nelson Mandela officially became South Africa's first post-apartheid era president 24 years ago, the legacy of apartheid lives on today. Black South Africans continue to be disproportionately affected by poverty, widespread illness and disease, inferior learning opportunities, and inadequate access to clean water, sanitation facilities, and electricity. Since the end of apartheid, only 4% of South Africa's available arable land has been transferred to black South Africans through the formal land reform system (McLachlan, 2009). The result of these continuing inequalities is growing frustration, which has exacerbated an already volatile situation and led to "eruptions of violence" (Clark and Worger, 2016). Being a white farmer in South Africa is now considered to be one of the most dangerous professions in the world with a rising murder rate that was roughly eight times higher than the national average in 2010 (Goldblatt, 2010). Violence against immigrant job seekers from other African countries has also erupted during the last decade as poorer South Africans see them as competition for scarce jobs and resources (Clark and Worger, 2016). The persistent poverty, economic inequality, racial tension, and growing violence plaguing South Africa will naturally affect entrepreneurial endeavors or development initiatives, so every effort should be made to design solutions to social problems within the context of this complex historical past.

Food Insecurity

Despite numerous food fortification, food supplementation, and school feeding programs that aim to reduce food insecurity in South Africa, many families remain food insecure today. Lbdarios et al. found that within South Africa, one out of two households experience hunger, one out of three households are at risk of hunger, and only one out of five are food secure (2008). People living in rural areas experience higher rates of food insecurity (nearly 35%) compared

with people living in urban areas (roughly 20%) (Labadarios et al., 2011). The most frequently consumed foods in the country are cornmeal, whole milk, and bread. Poorer and rural households have, on average, only five different food items in their home, showing the severe lack of dietary diversity that is closely linked to food insecurity (Labadarios et al., 2008). In his review of South Africa's national food security surveys, Labadarios concludes that South African households have "alarmingly" low dietary diversity and food variety scores, both of which are positively related to children's nutritional status, and that South African children do not receive the nutrients needed to meet their nutritional requirements (2011).

Food insecurity and low dietary diversity are also linked to harmful nutritional deficiencies and chronic illnesses. Faber and Wenhold point out that nutritional deficiencies can encompass both "infectious diseases associated with under-development, poverty and under-nutrition" as well as "chronic diseases linked to over-nutrition and a western type of diet and lifestyle" (2007). In South Africa, undernutrition and overnutrition coexist, leading to a number of serious health issues (Faber & Wenhold, 2007). Nationally, 33.3% of preschool children are vitamin A deficient and 21.4% of preschool children are anaemic (Faber & Wenhold, 2007). 20-29% of children ages 6 months to 6 years suffer from stunting, a developmental issue caused by malnutrition that results in a low height for age (Faber & Wenhold, 2007) 52.3% of South African women are either overweight or obese, and one study found that 19% of three-year- old children in the central region of the Limpopo province were both stunted and overweight (Faber & Wenhold, 2007). Making nutrient-dense food affordable and readily available, as well as educating people about the benefits of eating a whole food diet, could drastically improve the health and wellbeing of all South Africans, especially those who are poor or living in rural areas.

Youth Unemployment

Youth[4] unemployment is one of the most pressing issues facing South Africa today. From 2008 to 2014, youth unemployment increased from 45.6% to 51.3%, the largest increase in unemployment among any age group (Statistics South Africa, 2015). In particular, long-term unemployment increased more for youth than any other age group (Statistics South Africa, 2015). In 2016, South Africa had the third highest youth unemployment rate in the world, leading to despondency among South African youth and causing many to stop looking for work completely (World Bank Development Indicators, 2016; Development Policy Research Unit, 2012). Young adults defined as discouraged workseekers[5] increased from 820,000 in 2008 to 1.6 million in 2012 and comprise 70% of the share of total discouraged workseekers (Development Policy Research Unit, 2012). Other studies have shown discouraged workseekers, as opposed to the narrow unemployed[6], to be more likely to reside in more rural provinces, such as Limpopo, to be under the age of 25, to be less mobile due to financial constraints, and to have low levels of education (Yu, 2013).

Within South Africa, the Limpopo province is particularly affected by the unemployment crisis. It is easy to overlook the economic stress in Limpopo at first glance because it currently has the lowest unemployment rate (19.1%) of any province in South Africa (Statistics South Africa, 2017). The official unemployment rate, though, only includes 15-64 year olds who are unemployed *and currently seeking work.* It does not include persons between the ages of 15-64

[4] "Youth" is defined as persons between the ages of 15-24 by the World Bank and persons between the ages of 15-34 by Statistics South Africa.
[5] Discouraged workseekers are defined as unemployed persons who are no longer seeking employment.
[6] Narrow unemployed are defined as persons who are unemployed but actively seeking employment.

who are not economically active because they are studying, ill, or so discouraged about their employment prospects that they are no longer looking for work. In 2014, 12.3% of unemployed youth in the Limpopo province were categorized as 'discouraged workseekers,' the highest rate of any province in the country (Statistics South Africa, 2015). Limpopo is currently tied with the Kwazulu-Natal Province for the lowest Labor Force Participation Rate in the country at 48.6% (Statistics South Africa, 2017). This means that 51.4% of the adult population in Limpopo is not working or seeking work, and therefore not counted in the official unemployment rate.

Table 1: South African labor statistics by province

Province	Unemployment Rate	Labor Force Participation Rate
Eastern Cape	35.5%	52.4%
Free State	31.8%	63.8%
Gauteng	30.2%	72.5%
KwaZulu-Natal	24.6%	48.6%
Limpopo	**19.1%**	**48.6%**
Mpumalanga	30.7%	60.6%
North West	26.2%	52.8%
Northern Cape	29.2%	55.6%
Western Cape	21.9%	68.5%
Eastern Cape	35.5%	52.4%

Low Education Levels

These staggering rates of unemployment can in part be traced back to South Africa's underperforming education sector. Nationally, only 51.2% of females and 48.8% of males between the ages of 20 and 24 have completed secondary education (Statistics South Africa, 2017). Among adults over the age of 20 in the Polokwane Municipality, the percentage of people who have completed secondary education falls to 29.5% (Statistics South Africa, 2017). In a 2013 report, the Centre for Development and Enterprise concluded that "most South African

pupils cannot read, write and compute at grade-appropriate levels, with large proportions being functionally illiterate and innumerate" (Spaull, 2013). The report goes on to say that only 50% of students will make it to Grade 12, only 40% will pass Grade 12, and only 12% will qualify to attend a university (Spaull, 2013). Additionally, young adults who do not acquire a post-secondary education are at a distinct disadvantage, struggle to find full time work, and are more likely to be unemployed for long periods of time or permanently (Spaull, 2013). These statistics shed light on a crisis happening in South Africa's education sector, resulting in large numbers of young adults with low education levels and limited professional opportunities.

Agricultural Entrepreneurship

High youth unemployment rates represent a staggeringly inefficient use of the available human capital in South Africa, hindering socio economic progress across all strata of society. Integrating youth into the economy is critical to the future success of South Africa, and entrepreneurship is one way to accomplish this goal. Entrepreneurship is a key opportunity for unemployed youth to generate an income and integrate into society (Agriculture for Impact, 2014; YouthPower, 2018). An additional benefit of engaging young people in entrepreneurship is that young entrepreneurs tend to hire other young people as employees, triggering a ripple effect that lifts even more young people out of poverty (Agriculture for Impact, 2014). Youth generally have a favorable perception of entrepreneurial activities, and rural youth are particularly enthusiastic about engaging in entrepreneurial activities. 25% of rural youth versus 19% of urban youth currently have plans to start a business (Agriculture for Impact, 2014).

Investing in agricultural entrepreneurship, in particular, has the potential to positively impact communities in South Africa by providing youth with a way to make money while also increasing the amount of healthy, accessible food available in rural communities. Unfortunately,

youth interest in agriculture is often low (Agriculture for Impact, 2014; Brooks et al., 2013; Cassinath et al., 2016; Filmer et al., 2014; Food and Agriculture Organization, 2013; Nadeau et al., n.d.; Vargus-Lundius & Suttie, 2014; YouthPower, 2018). Agriculture presents numerous challenges, especially in rural communities, and youth see agriculture as "outdated, unprofitable and hard work" (Agriculture for Impact, 2014). As the Food and Agriculture Organization of the United Nation concludes, "with the estimated age of farmers at 60 in Africa and armed on average with a thousand-year old technology of the hand-hoe, it is not surprising that youth do not find agriculture 'sexy'" (2013). Agricultural education in Africa is often outdated, focusing almost exclusively on farm production and ignoring other important areas of agribusiness such as agricultural inputs, market development, food processing, and supply chain management, which are often more interesting economic avenues for youth (Food and Agriculture Organization, 2013).

Environmental Constraints: Water, Soil, and Land

One of the most difficult challenges for food producers in rural Limpopo to overcome is water scarcity (Blignaut et al., 2014; Consultative Group for International Agricultural Research, 2014; Plott, 2009; Vink, 2009; World Wildlife Fun, 2010). South Africa is a country that experiences frequent and prolonged droughts (Vink, 2009). 50% of South Africa's catchments are already over-allocated, and socio-economic shifts and climate change are predicted to exacerbate issues related to water scarcity in the future (Pott, 2009). The Limpopo River Basin, which encompasses the area where this research will take place, is one of the driest regions in the world. The region receives an annual rainfall average of only 200-1,500mm, and among the six basins studied around the globe during the second phase of the Consultative Group for

International Agricultural Research's (CIGAR) Challenge Program on Water and Food (CPWF), the Limpopo River Basin was the driest (2014).

Personal research conducted in November 2015 confirmed that water scarcity is a major concern among residents of rural communities in Limpopo. Water scarcity was the number one reason given by survey participants to explain why they do not grow their own produce. Four of the five key informants interviewed cited water as a major issue affecting food production in South Africa. Even in a limited geographic location, water availability varies greatly from one village to another. While residents of some villages described having access to modern piped water in a relatively convenient location, residents of other villages described still having to walk long distances to access a water source. In one interview, the director of a local youth center explained that the center had a vegetable garden at one time that was meant to supplement meals for the children and generate money for organizational sustainability, but it failed due to an insufficient water supply. In another interview, a local resident described how her family plants corn, sweet potatoes, and peanuts in a field every year, and if rains come at the right time, they are able to process and store large amounts of food for the year. However, if rains do not come at the right time, the crops die, and they instead have to use precious resources to procure these items from a grocery store.

Soil degradation is another major factor hindering food production in South Africa. Only 12% of the country's land has both the necessary rainfall and the fertile soil needed to grow food (World Wildlife Fund, 2010). 95% of South Africa's food is produced by commercial growers who are heavily dependent on chemical fertilizers to maintain yields (Blignaut et al., 2014). 60% of South Africa's cropland has moderately to severely acidic topsoil, and 15% of its cropland has acidic subsoil (Blignaut et al., 2014). Poor soil quality can be particularly challenging in rural

communities, many of which are situated on apartheid-era homelands. When the colonial government forced black South Africans to resettle in assigned homelands, it also situated these homelands on the most infertile and ecologically sensitive soils in the country (Hoeks, 2014). As rural populations grew, these homelands "deteriorated under the weight of overcrowding and severe socio-economic constraints" (Hoeks, 2014). At the height of Apartheid, the colonial government's-imposed system of racial segregation that lasted from 1948-1994, 83% of the population (mostly non-whites) lived in rural homelands constituting 13% of the nation's land, while 16% of the population (mostly whites) lived on commercial farms constituting 85% of the nation's land (Clover & Eriksen, 2009).

Another major environmental constraint rural food producers face is increasing land scarcity, which has become a growing concern across the whole of Sub-Saharan Africa as populations increase and available lands that can be allocated through traditional land tenure systems decrease. Land scarcity is further complicated in South Africa by an agriculture industry that continues to be marred by complex issues of racial inequality and social injustice. It remains largely segregated, with the vast majority of commercial farms still owned by white South Africans who employ large numbers of black South Africans to work as unskilled farm laborers. According to the Development Bank of Southern Africa, only about 4 million hectares, or 4% of South Africa's available arable land has been transferred to black South Africans through the formal land reform system, which is far below the target goal of 30% (McLachlan, 2009). Even more distressing, the government acknowledges that new land reform projects fail as much as 50% of the time (McLachlan, 2009). The result is that today, many black South Africans continue to survive on small, infertile plots of land with limited access to rich soils and water, making rural food production very difficult.

Controlled-Environment Agriculture as a Potential Solution

CEA techniques, including hydroponics, aeroponics, and aquaponics provide a potential solution to many of the challenges facing South African food production (du Plooy et al., 2012). CEA can conserve enormous amounts of water, using up to 80% less water than traditional methods. When integrated with vertical growing, these systems have the potential to make the most of the limited space available in increasingly crowded villages. Because these systems are typically set up in an indoor controlled environment, plants are protected from unpredictable weather events, including droughts and floods. They also provide growers much higher income potential by offering year-round growing seasons, higher yields, and shorter gestation periods. Hydroponically grown leafy greens can yield as many as eight crops per year, compared with three crops per year from conventional outdoor farms. Additionally, strawberries can yield up to 30 times more produce per acre compared to conventional outdoor farms (Desppmmier, 2009; 2010; 2013). They are also scalable and can be located in urban, peri-urban, or rural areas regardless of environmental conditions, meaning that more people would be able to access fresh food without traveling long distances to grocery stores.

Academics and innovators in the international development community are starting to recognize the potential of CEA technologies. Securing Water for Food, a joint development effort between USAID, the Ministry of Foreign Affairs (Netherlands), the Swedish International Development Cooperation Agency, and the South African Department of Science and Technology, has invested $35 million in innovative projects around the world that aim to grow more food with less water including: 1.) Hydroponics Kenya, Ltd., a for-profit enterprise that designs and installs simplified hydroponics systems for low income farmers in Kenya, saving more than 450,000 liters of water to date; and 2.) The Water Governance Institute, a non-

profit organization that works to promote aquaponics farming among smallholder farmers in Uganda, providing on average a 10-25% increase in crop yields and a 100% return on their $700 investment within one year (2017).

A case study published by the Food and Agriculture Organization evaluated the effectiveness of simplified hydroponics systems to improve nutrition for 2,567 children living in 54 child development centers (CDCs) in urban, peri-urban, and rural areas of Ecuador. In this project, 70% of the crops produced were used to feed the children, and 30% of the crops produced were sold to community members to generate sustainability funds. The study found that the hydroponics systems provided greater dietary diversity to the children living in CDCs and improved their health by reducing instances of respiratory infections and diarrhea when compared to children living in the same CDCs in previous years and children living in CDCs without a simplified hydroponics system in the same year. The study concluded that simplified hydroponics systems can be an effective tool for improving food security and nutrition in low-income rural and peri-urban communities around the world (Izquierdo, et al**.)**.

The development community in South Africa is in the early stages of testing and evaluating the outcomes of CEA technologies as well. South Africa's Agricultural Research Council, Vegetable, and Ornamental Plant Institute (ARC-VOPI) has partnered with the Gauteng Department of Agricultural and Rural Development (GDARD) to develop an integrated program to assist hydroponic vegetable farmers in South Africa (du Plooy et al., 2012). In an effort to evaluate the effectiveness of this program, a student researcher at the University of the Free State interviewed 38 participants from the urban area of Tshwane, South Africa (Morifi, 2017). The data revealed that new technology provided by the program helped farmers increase production and sales, as well as improve the quality of their produce and reduce waste. The study concluded,

however, that the hydroponics systems were ultimately not sustainable due to insufficient ongoing training and technical support (Morifi, 2017). Results of personal communication and research also suggest that CEA growing methods generate excitement in young South Africans who see traditional agriculture as antiquated and unappealing. If this excitement could be used to encourage young adults to enter the field of agriculture, it could serve as one piece of the solution to increasing rural food security and decreasing youth unemployment in South Africa.

METHODS

Research Approach

This study utilized a qualitative approach to measure participants' attitudes and perceptions towards traditional agriculture and CEA. More specifically, the researcher moderated focus groups comprised of young adult participants from rural areas in Limpopo, South Africa. Focus groups were selected as the primary research tool because they are particularly well suited to measure participants' attitudes, perceptions, thoughts, and opinions about a certain topic (Greenbaum, 2000; Kitzinger, 1995; Krueger, 2015). Focus groups measure not only what people think, but how and why they think that way, providing a deeper understanding of the given topic (Greenbaum, 2000; Kitzinger, 1995; Krueger, 2015). They minimize the threat of excessive influence from the interviewer by employing primarily open-ended questions that let participants control the direction of the discussion (Krueger, 2015). This encourages participants to "become an active part of the process of analysis," which makes focus groups well-suited for researchers concerned with empowering research participants (Kitzinger, 2015). Focus groups have the potential to produce more natural and accurate results than one-on-one interviews because our attitudes and perceptions are often not concrete, but influenced by others. We sometimes need to listen to others' opinions before fully forming or being able to articulate our own. (Greenbaum, 2000; Kitzinger, 1995; Krueger, 2015). Lastly, focus groups were chosen as the primary research tool for this study because they are particularly sensitive to cultural variables, and therefore well-suited to cross-cultural research. (Kitzinger, 1995).

Role of the Researcher

Because this study utilized qualitative research methods, which require the researcher to serve as the primary instrument for data collection and interpretation, it was important to identify

and work through the researcher's personal values, assumptions, and biases up-front. The researcher is a thirty-year-old, white, female born in a small town in north-central Indiana and currently residing in Indianapolis, Indiana. She earned a Bachelor of Arts Degree with a double major in International Studies and Economics and is currently earning a Master of Science Degree in Natural Resources and Environmental Management. She has seven years of professional experience that encompasses roles in international grassroots community development, fundraising, and grant writing. In 2010, she moved to Limpopo, South Africa and spent four years working with youth and community development organizations to empower marginalized rural communities. She was often surrounded by passionate local community members who were motivated to launch projects and promote good in their communities. She regularly interacted with young adults who were frustrated with the lack of quality educational and professional opportunities available to them. Her perception was that these people were motivated and capable of effecting positive change in their communities, but that they lacked the opportunities and support necessary to be successful. In 2016, she had the opportunity to attend the Youth Economic Opportunities Summit hosted by Making Cents International in Washington D.C. She attended several sessions and panel discussions focused on why young adults around the world are leaving the agriculture industry and what can be done to counter this trend. The consensus from several top international development organizations was that young adults become motivated to engage in agriculture when their perception of agriculture is modernized and they believe their endeavors will provide immediate financial benefits.

To work through potential personal biases associated with these background experiences, the researcher wrote a bracketing journal prior to engaging in the research. This journal was then shared with her research advisor for feedback. The bracketing journal was also maintained

throughout the research process, allowing the researcher to take note of any potential pre-conceived notions or assumptions that arose. The bracketing journal exercise revealed that, as a result of these past experiences and observations, the researcher may be prone to expect that young people will have positive attitudes and perceptions towards launching entrepreneurial endeavors. Based on the sessions attended at the Youth Economic Opportunities Summit, the researcher may expect that, if participants are introduced to updated methods of agriculture that provide financial benefits, they will be interested in engaging in agriculture. She may also assume that quality training and capacity building opportunities related to agriculture, hydroponics, and/or entrepreneurship are not locally available because she was not aware of any such opportunities during the four years she spent living in Limpopo. After acknowledging these potential biases, every effort was made to put them aside in order to interpret the research data objectively.

Bounding the Study

The researcher traveled to the Polokwane Municipality of the Limpopo Province of South Africa for three and a half weeks in August/September 2017 to conduct the study. The Polokwane Municipality was chosen as the research site in part because the researcher lived and worked in the area from 2010-2013, and has close connections with a number of local communities and organizations. The Polokwane Municipality has a total population of 628,999 and a youth (ages 15-35) unemployment rate of 42% (Statistics South Africa, 2017). Water is scarce, with only 33.7% of residents having piped water inside their dwelling (Statistics South Africa, 2017).

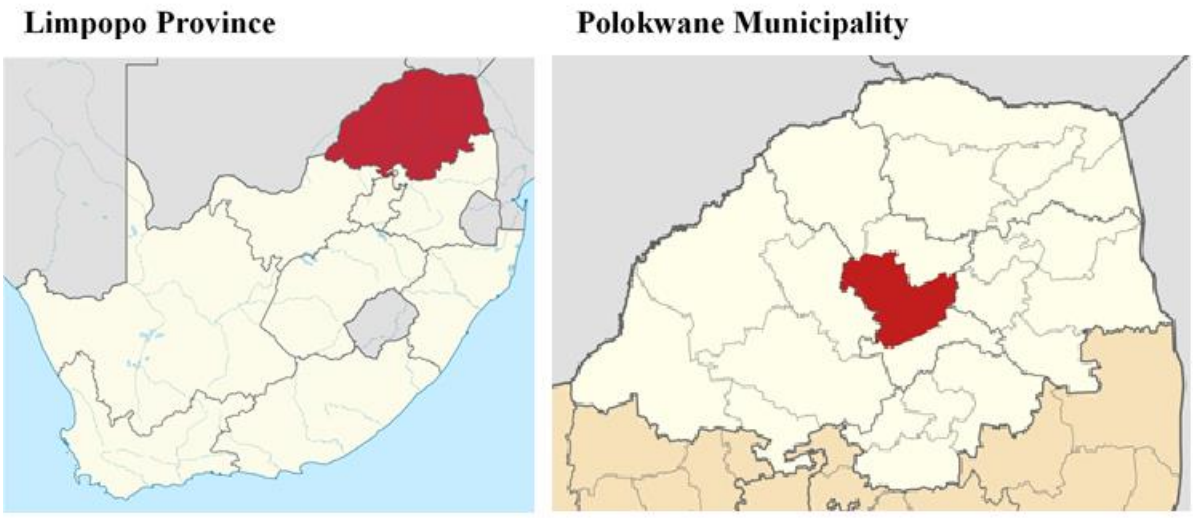


Figure 1: Maps of Limpopo Province and Polokwane Municipality

The study utilized young adult participants to take part in focus groups. All participants were proficient in conversational English, but not necessarily literate. A translator was available to help participants translate written documents, as needed. Although focus group participants were required to be proficient English speakers, it was assumed that necessary use of advanced and/or unfamiliar vocabulary, as well as cultural differences between the participants and the researcher, may lead to misunderstandings. Therefore, a translator also served to monitor communication during all three focus group sessions, addressing any instances of miscommunication and validating that communication was clear between the researcher and participants.

Because human subjects were included in the study, the researcher made every effort to address any potential ethical concerns. She completed the Institutional Review Board's (IRB) Collaborative Institutional Training Initiative and followed all guidelines and procedures prescribed by the IRB. She also submitted a research proposal to the IRB for review and approval prior to collecting any research data. The purpose and procedures of the study were fully explained to each participant, both verbally and in writing. Each participant signed an

informed consent waiver stating that he or she understood participation was voluntary and they were free to quit the study at any time. Participants also signed informed consent documents stating they understood their comments are not confidential and may be used in publications.

Data Collection

Three focus groups were conducted in three separate communities within the Polokwane Municipality: Mountain View, Segwashi, and Masealama. The researcher partnered with Thusanang Trust (Thusanang), a non-profit organization focused on early childhood and community development in the Limpopo Province, to conduct the focus groups. Specifically, Thusanang printed and dispersed recruitment flyers and participant applications, collected participant applications, provided meeting space for all three focus groups, and provided a translator to assist with communication needs during the focus groups.

Participants were required to be young adult community members between the ages of 18 and 34[7] and proficient in conversational English. To ensure all participants met this selection criteria, interested persons were required to fill out a short application. Participants who did not meet the minimum selection criteria were removed, then seven participants from each of the three target communities were selected. In an effort to represent each gender equally in the data, a minimum of three males and three females were invited to take part in each focus group. Otherwise, participants were selected randomly. Each participant was given a stipend of R50 (~$3.85, slightly higher than the average compensation for a half day of unskilled labor), to incentivize participation.

[7] While the World Bank Development Indicators define youth as individuals between the ages of 15 and 24, Statistic South Africa and South Africa's Youth Development Agency Act of 2008 define youth as individuals between the ages of 15 and 34. This study targeted all persons included in the Youth Development Agency Act, with the exception of minors under the age of 18 due to liability considerations.

Focus groups were constructed around open-ended questions designed to encourage participants to lead the conversation. Each focus group included six sessions facilitated over the course of approximately two and a half hours, and followed the same format for consistency.

Table 2: Focus groups structure

Time	Topic / Activities
15 Minutes	***Introduction to the Researcher & Research Project***
20 Minutes	***Participant Introductions & Ice Breaker***
30 Minutes	***General Participant-Led Discussion about Traditional Agriculture*** Questions posed by the researcher to generate discussion included: 1. What are your perceptions of agriculture/food production? 2. What are your feelings towards starting and operating your own business? 3. What challenges come to mind when you think of agriculture/food production in your community? 4. What opportunities come to mind when you think of agriculture/food production in your community? 5. What are your feelings towards operating your own food production business in your community? 6. Are you aware of any training opportunities related to agriculture or entrepreneurship, and if so, what are your perceptions of these training opportunities?
45 Minutes	***Introduction to Controlled-Environment Agriculture*** It was assumed that at least some participants would not be familiar with CEA. Handouts and videos were used to introduce all participants to this method during this session. The same set of resources were used for each focus group and the researcher made every effort to find and utilize informative, unbiased resources that participants could relate to. The handouts introduced participants to the definition of CEA (humans controlling some aspect of food production that would otherwise be controlled by nature); potential characteristics of CEA systems (soilless growing, efficient use of water, gestation periods, etc.); the components of a basic deep-water culture hydroponic system; and the components of a basic aquaponics system. The handouts used can be found as Appendices A-D. To build on the concepts introduced in the handouts, the participants then watched three short videos: 1. Dutch Bucket Hydroponic Vegetable Example (7 Minutes: https://www.youtube.com/watch?v=nOMIZ7LVMeE): This video gave a

	tour of a low-tech dutch bucket hydroponic growing operation in Kenya. The farmer in the video discusses growing lettuce, tomatoes, and fodder for cattle using CEA. 2. Hydroponic Animal Feed Example (6 Minutes: https://www.youtube.com/watch?v=U9Wm0v5wHlI): This video gave a tour of a second low-tech dutch bucket hydroponic growing operation in Kenya, this one focused primarily on growing fodder for animal feed. It highlights the farmer's innovation in terms of utilizing locally available resources (cut trees, straw, etc.) to build greenhouses and animal enclosures. 3. Cape Town Aquaponics Example (2 Minutes: https://www.youtube.com/watch?v=mGB-gVroKo8) This video introduces viewers to a high-tech urban aquaponics operation in Cape Town, South Africa. The systems requires multiple holding tanks, electricity, and water pumps, producing both fish and vegetables for human consumption.
30 Minutes	***General Participant-Led Discussion about CEA*** Questions posed by the researcher to generate discussion included: 1. What are your initial perceptions of controlled-environment agriculture as opposed to traditional agriculture? 2. What do you find surprising or interesting about controlled-environment agriculture? 3. What are your thoughts about young people using controlled-environment agriculture to grow and sell food for a profit? 4. What challenges do you see young people facing who may be interested in pursuing controlled- environment agriculture in your community? 5. What opportunities do you see for young people who may be interested in pursuing controlled- environment agriculture in your community? 6. How would you feel about investing your time and/or money into learning more about controlled- environment agriculture as a way to generate income?
10 Minutes	Conclusion

Data Recording and Analysis

All data collected during the focus groups was audio recorded and transcribed. The researcher also took detailed field notes during the focus groups to capture nonverbal observations and protect against the possibility of recorded data being lost before it was

transcribed. After completing transcriptions, the researcher completed a thorough review of all available data. She then read through the data several times in more detail, labeling segments and quotes with a descriptive word or heading as she read. Initially, the labels were broad (e.g.: Economic Concerns), but they became more narrow and focused (e.g.: Competition from Local Competitors; Lack of Startup Capital; Etc.) as she read and reread the transcripts. Data material belonging to the same category was then organized in one central location and analyzed to draw conclusions about common themes and develop detailed descriptions of what research participants said as a whole. As the data was coded and organized, 14 key themes emerged under the umbrella of "Traditional Agriculture" (e.g.: Economic Benefits; Water Scarcity). 10 Key themes emerged under the umbrella of "Controlled Environment Agriculture" (e.g.: Reduction of Hard Labor; Lack of Startup Capital). After categorizing the data, the researcher set out to interpret the meanings of these themes and provide recommendations for further research and action.

Data Validation

Data was validated utilizing five validation strategies taken from John W. Creswell's book, *Research Design* (2014)*:*

1. Data was triangulated, meaning that data sources from this study (data sets from each of the three focus groups) were compared against one another and against outside sources (e.g.: related literature; preliminary research conducted by the researcher in 2015 in the same geographic area; information presented by international development organizations at the 2015 Youth Economic Opportunities Summit) to ascertain whether coherent themes emerged.

2. The researcher uses rich, thick description to give readers a thorough sense of the research setting and participants, thereby offering many perceptions of identified themes.
3. The researcher completed bracketing exercises prior to collecting any data and maintained a bracketing journal throughout the research process in order to acknowledge personal biases and make every effort to put them aside.
4. The researcher clearly and openly communicates all potentially discrepant information that may run counter to the identified themes. This information has not been hidden, but embraced to paint a more complete and realistic picture of research findings.
5. The researcher employed peer debriefing, the process of asking other peers and/or researchers to review and ask questions about the completed study. This process increases accuracy and illuminates any potential gaps in the research or researcher's report.

RESULTS

Introduction of the Setting

Masealama, Mountain View, and Segwashi villages share many similarities. They are located within the Polokwane Municipality, inhabited almost exclusively by black Sepedi-speaking South Africans, and experience high rates of poverty and sub-standard living standards (piped water, flushing toilets, electricity, etc.). They are all easily accessible from main paved thoroughfares and located within 30 kilometers of Mankweng, an important commerce area that encompasses the University of Limpopo, a handful of major retail and grocery establishments, and numerous local market vendors and restaurants. They are all formal settlements, meaning they have a local governing structure and are recognized by the national and municipal governments.

There are no paved roads within the villages. Instead, dirt roads, some well maintained and others in various states of decay, wind through the villages connecting dwellings, informal shops known as "spaza shops," unlicensed drinking establishments known as "shabeens," early childhood education centers, and schools. It is common for South Africans to dig up and remove all natural greenery, so village landscapes can appear especially brown and dusty. Each village seems to have a few ornate, finished, and well-manicured houses, but for the most part, dwellings appear informal and basic. Most dwellings are made with dirt or concrete floors, metal roofs, and brick walls with no insulation. South Africans are known for building dwellings room-by-room over many years, or even many generations. For example, a family may build one small room, then slowly accumulate enough bricks and other materials over the next 5-10 years to add a second room, and so on. For this reason, the landscape in rural villages often appears chaotic and chronically "under-construction" to outsiders.

Table 3: Key demographics by village (Statistics South Africa, 2017)

Indicator	Masealama	Mountain View	Segwashi	Polokwane Municipality
Population	271	2,030	3,418	628, 999
People Aged 20+ who Completed High School	26.6%	26.6%	19.7%	29.5%
Dwellings with Piped Water	0%	3.3%	1.4%	33.7%
Dwellings with Electricity	39.6%	83.9%	96.6%	83%
Dwellings with a Flush Toilet	4.4%	0.9%	0.2%	41.1%
Distance to Nearest Major Area of Commerce (Mankweng)	20.5 km	16.9km	28.3km	n/a

Each of the villages has its own set of unique characteristics too, of course. Masealama, for example, is significantly smaller than the other two, with a population of only 271 people compared to 2,030 people (Segwashi) and 3,418 people (Mountain View). Masealama is known for its strong sense of community and social activism. It is the site of what was once a major Lutheran church mission, spanning multiple buildings that housed a church, parsonage, school, and trade school. Today, the mission is operational, run by local South African clergy, but most of the buildings sit empty and unused, and its influence in the community is less prominent than what it once was.

Segwashi is one of the oldest and most established villages in its immediate surroundings. It is historically intertwined with Hanertsburg, a small predominantly white village situated 15 kilometers away with a population of 282 people and an economy built mainly around agriculture and tourism. Many residents of Segwashi travel back and forth to Haenertsburg each day to work as maids, gardeners, farm workers, or store clerks. Stevens Lumber Mill, located just across the main highway from the village, is also a major source of employment for residents. The community has unusually high rates of electricity coverage for a rural village, but struggles

with low quality education, resulting in less than 20% of residents over the age of 20 having completed high school (Statistics South Africa, 2017).

Mountain View is a more disjointed community than Masealama or Segwashi, possibly a result of its larger size. Some participants had to find transportation to the research site because they lived too far away to walk. Participants described how the village is sub-divided into distinct sections and people living in different sections may not know one another. Mountain View is also located less than 3 kilometers from the headquarters of the Zion Christian Church (ZCC), one of the largest African-initiated churches in the world with a membership of more than 4.9 million people (Muller, 2011). Church activities are a big part of life for many residents of Mountain View.

The setting of the Mountain View and Segwashi focus groups were strikingly similar. They both took place at early childhood centers affiliated with Thusanang. Little children played games outside and peeked through the windows at us as we talked. Colorful educational posters and homemade learning resources hung on the walls and lined the floors. The discussion in Masealama took place in a building that makes up part of the Lutheran church mission compound. This particular building most recently housed a community youth development center that is not currently operational. Compared to the liveliness of the other two spaces, the site of the Masealama focus group felt distinctly quiet and devoid of people. Old faded artwork hung on the walls, and valuable equipment such as musical instruments, sports equipment, and laptops appeared to go unused, covered in a layer of dust. All three spaces were basic structures made of cinderblock walls and concrete floors. None of the buildings appeared to have electricity or running water, and they were outfitted with outdoor pit latrines. For all three focus groups, we sat in an informal circle on simple metal chairs, passing around juice and cookies as we talked.

Introduction of the Participants

Men and women between the ages of 18 and 34 were recruited from these three villages to take part in the focus groups. The age distribution among participants was fairly even, including seven participants between the ages of 18-23, eight participants between the ages of 24-29, and five participants between the ages of 30-34. Females made up roughly 75% of participants, an issue that is addressed in the *Gender Considerations* section below. Table 3 (below) provides an overview of participant demographics broken up by village. Participants had varied backgrounds, interests, and personalities. Many participants discussed struggles related to unemployment and financial security. One participant discussed serving as a volunteer office administrator at a local high school. Several participants described running small entrepreneurial enterprises at some point in the past, though none of these enterprises seemed to be operational at the time the focus groups took place. None of the participants were from agricultural families or had strong agricultural backgrounds. When asked what drew them to the focus group, several participants responded that they wanted to learn more about agriculture. Many were surprised to hear that the researcher was interested in learning from *them* too. As anticipated, most participants from all three groups were initially shy and formal. The researcher's introduction to the study, as well as the planned ice breakers, encouraged the participants to relax. The ice breaker, which asked each participant to share something unique about him- or herself that wasn't true for anyone else in the group, generated laughter and lively discussion, helping to create an atmosphere of openness for the remainder of the sessions.

Table 4: Demographics of focus group participants by village.

	Name	Gender	Age
Mountain View	Kgopotso Senona	F	28
	Khomotso Bopape	F	33
	Marcus Mamabolo	M	23
	Sarah Mogashoa	F	30
	Nancy Masetla	F	24
	Karabo Morerwa	F	22
	Moses Motena	M	21
Segwashi	Thabang Mapheto	M	27
	Kgaugelo Makgoba	F	25
	Lina Tshepo	F	31
	Martha Letsoalo	F	25
	Johannes Phoshoko	M	21
	Maggie Mogashoa	F	22
Masealama	Phillip Senona	M	19
	Pheladi Letsoalo	F	31
	Alice Mehlape	F	27
	Elizabeth Maponya	F	27

Participant Engagement with Agriculture

Participants described low levels of engagement with traditional agriculture. Their engagement/interest levels can be divided into three broad categories:

1. *Currently Engaged in Traditional Agriculture:* Two of the 17 participants described being currently engaged in agriculture to some degree. Phillip currently works for a commercial cabbage operation and Karabo discussed assisting her mother with a subsistence garden.
2. *Interested but Not Currently Engaged in Traditional Agriculture*: Seven of the 17 participants (Khomotso, Thabang, Johannes, Martha, Kgaugelo, Maggie, and

Lina) described an interest in becoming engaged in traditional agriculture. Thabang was especially vocal about his interest, explicitly saying that he wants to launch a commercial enterprise and employ other people. The other six participants answered "yes" to the question of whether or not they are interested in engaging in traditional agriculture, but did not provide any additional insight that may speak to their level of interest and/or the specific type (subsistence, commercial, etc.) of agriculture they are interested in.

3. *Not Currently Engaged or Interested in Traditional Agriculture*: Eight of the 17 participants (Nancy, Sarah, Kgopotso, Moses, Marcus, Pheladi, Elizabeth, and Alice) expressed disinterest in becoming engaged with traditional agriculture.

Gender Considerations

A total of 21 participants- 12 females and nine males- were invited to take part in the focus groups. All 12 females showed up to take part in the focus groups, however, only five of the nine invited males showed up. This means that women made up just over 70% of study participants[8], potentially skewing the data to be more representative of women's views. When the researcher mentioned this issue to Thusanang's Executive Director, she expressed that Thusanang has also struggled at times to recruit engaged male participants for its projects. Her experience has been that female participants can be more reliable and committed to community development projects than their male counterparts. This is one of the reasons why Thusanag

[8] One male did not show up to take part in the Mountain View village focus group. One of the female participants brought along a friend, Nancy Masetla, to wait while she took part in the focus group. Nancy met the study's selection criteria (she was a resident of Mountain View, was between the ages of 18 and 35, and spoke fluent conversational English), so the researcher invited Nancy to fill the empty seat left by the absent male. This resulted in five females and two males participating in the Mountain View focus group.

facilitates self-help groups for women, but not men, in rural communities. They have found the groups to be more successful when they exclusively support and empower women.

While analyzing and coding the data, the researcher noticed that, even though female participants significantly outnumbered male participants, male attitudes and perceptions towards agriculture appear to be well-represented in the data. This can be attributed to the difference in the way males and females participated in the discussions. In general, the men who showed up to take part in the focus groups were very engaged and vocal. They were often the first participants to respond to the researcher's questions and were more willing to disagree with other participants and provide differing viewpoints. Female participants, on the other hand, were more varied in the way they engaged in the discussions. Roughly one third of female participants were as engaged and vocal as the male participants. They provided clear, powerful female voices to balance out the dominant male voices. Another third of the female participants were engaged in the discussion, but often waited to be encouraged or specifically called on by the researcher before contributing. Nevertheless, their contributions were valuable and clearly shaped the final data. The final third of female participants were generally shy and unwilling or unable to contribute to the discussions. Even when the researcher made specific efforts to encourage their participation (calling on them by name, encouraging them to speak in Sepedi, and/or asking simple yes or no questions), they provided very little feedback. It is interesting to note that female participation may have been influenced by the male/female ratio in each group. Female participation was strongest in Masealama where females made up 75% of participants; moderate in Mountain View where females made up 71% of participants; and weakest in Segwashi where females made up 67% of participants. This combination of a small number of dominant male voices and a large

number of varied female voices resulted in a roughly balanced mix of male and female views in the data.

Key Themes

Key themes emerged from the data illustrating the complex ways in which young adults think about and relate to agriculture. With a few exceptions, findings were consistent across the three target villages, and are therefore presented cumulatively below. As *Figure 2* illustrates, participants mainly discussed key themes in terms of 'Opportunities' and 'Barriers' as they relate to Traditional Agriculture and CEA[9]. Analysis of these key themes reveals that participants have primarily negative attitudes towards traditional agriculture due to the hard physical labor, environmental challenges, and financial challenges they associate with it. In contrast, participants expressed fascination and excitement about CEA, believing it has the potential to solve several challenges hindering traditional agriculture. While they expressed optimism towards CEA, they also acknowledged that it is constrained by its own challenges, and that these challenges would need to be addressed before CEA-centered development interventions could be successful.

[9] There was some uncertainty or disagreement about how to categorize 'food security' and 'community support' as they relate to CEA, thus a third category was formed for key themes related to CEA.

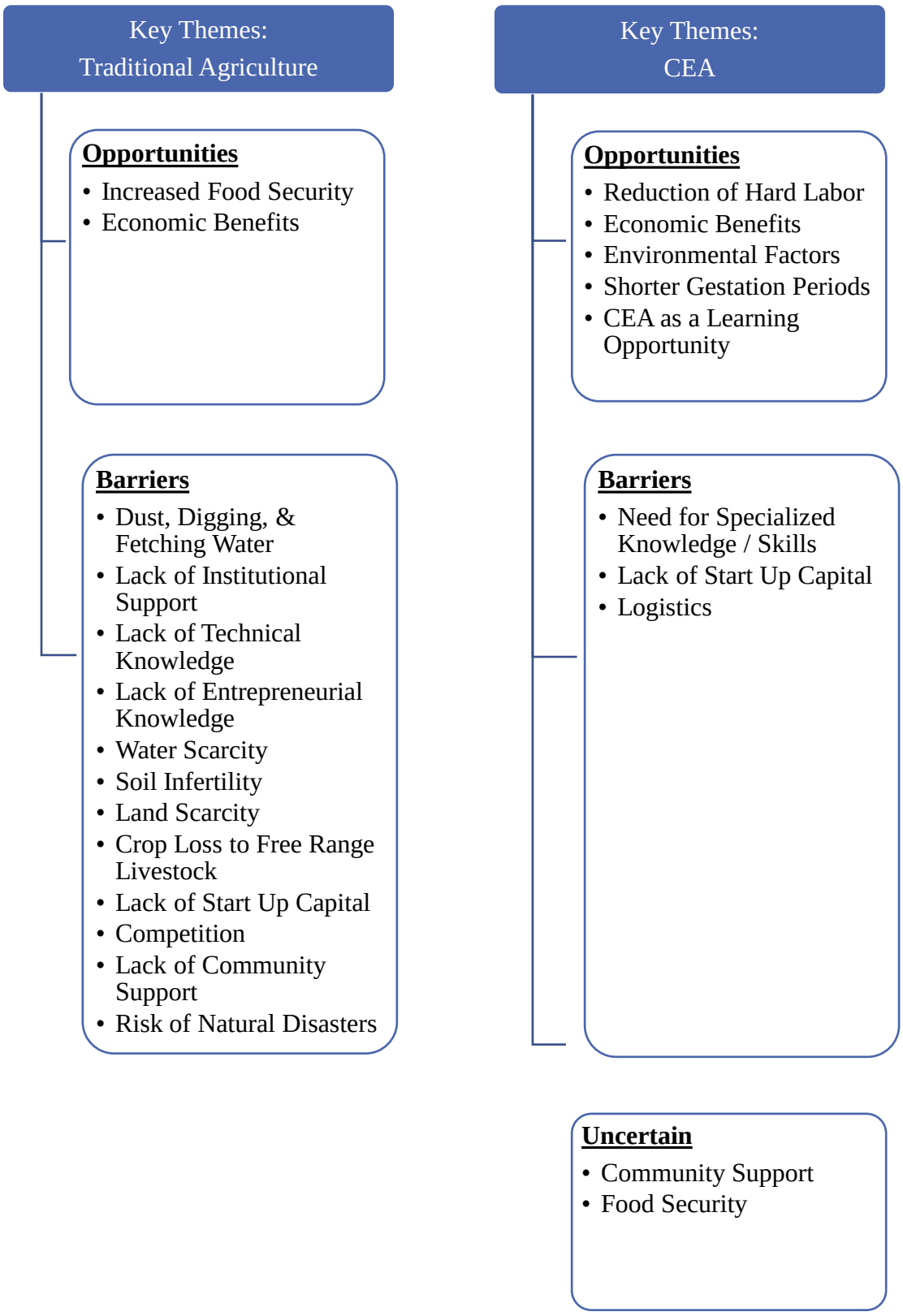


Figure 2: Overview of key themes

Key Themes: Traditional Agriculture

Each focus group began with a broad introductory question: "What are your general perceptions of agriculture?" Responses were varied and provided an overview of participants' understanding of agriculture prior to being introduced to CEA. When discussing what agriculture is, participants mainly described small-scale vegetable gardens that are planted and maintained by hand, as well as small free-range cattle operations dependent on public grazing. More advanced agricultural tools and methods such as tractors, tillers, and/or irrigation systems were not mentioned, suggesting that participants do not associate these more modern technologies with rural agriculture. Several participants expressed disinterest in agriculture and described agricultural activities as "hard labor."

Despite the perception of agriculture as difficult, there was wide consensus that agriculture is important. Thabang said "when I think about agriculture, I think about life… without food, we can't live," while Wilhemina stated "agriculture is very important in our village because we depend on it." One participant described how, when community members struggle with food insecurity, they sometimes call on neighbors and friends with small home gardens to provide emergency food items. This combination of agriculture being perceived as difficult but important led to varying levels of interest in agricultural endeavors among participants, as described above in the *Participant Demographics* section.

In all three focus groups, agriculture was described as not widely-practiced in their communities. There was a general consensus among all three groups that *some* but not *a lot* of people in their villages maintain home gardens. Participants from Mountain View and Segwashi were unable to identify any concrete commercial agricultural operations. Although they described agriculture as not widely practiced, participants from Masealama were able to identify

five active commercial agricultural operations in the village: 1.) a cattle farmer who raises and sells cattle; 2.) a vegetable grower who sells produce to people inside and outside the village for large events such as weddings and funerals; 3.) a group of elderly women who maintain a cooperative garden and sell produce to wholesale distributors outside the village; 4.) a cabbage operation that employs 10 people and sells cabbages to wholesale distributors outside the village; and 5.) a primary school that maintains a vegetable garden in order to provide nutritious meals to students, as well as bring in additional income for the school.

Opportunity 1: Increased Food Security

Some participants believed that engaging in local agricultural activities can help provide food to poorer households at a lower cost. Johannes believed that having a home garden is "good for not spending a lot of money" and Marcus expanded on this idea by explaining that many families from rural areas do not have money to buy basic food stuffs, and therefore benefit from being able to augment their diets with nutritious vegetables from home gardens. Lina added that maintaining home gardens can be especially beneficial for people suffering from illnesses because gardens provide affordable nutritional benefits that support recovery. Alice also discussed how maintaining home gardens can save money by reducing the need for poor community members to pay for transport to and from distant grocery stores: "Agriculture, ne, it is something that we should consider doing it for our own area because it saves lives… that R10 that you use to go and buy spinach, you use it for something else." Khomotso echoed these sentiments, explaining that when she used to sell produce at a roadside stand outside the village, friends and family members would call and ask her to bring some produce home for them because "there are no vegetables here."

Opportunity 2: Economic Benefits

Participants were somewhat divided in their opinions regarding the economic benefits of traditional agricultural. There was a strong consensus in all three focus groups that, when successful[10], entrepreneurial activities of any kind are beneficial to rural communities. Karabo said:

> *For me, I think it is a good thing because according to our country… we are a developing country… there are no jobs, there are not, so if you try to make your own business, you empower yourself, you provide jobs for the rural people.*

Elizabeth agreed, saying "it's about empowering each other, because if I support him, he gets a job." Perceptions of agricultural entrepreneurship in particular were more varied, but some participants expressed optimism about its potential to provide economic benefits. Phillip explained that he believes agricultural entrepreneurship is a promising field because food is in constant demand: "there's no time whereby let's say food is no longer required in South Africa, no, such a time will never come." Thabang agreed and expressed a desire to contribute to wealth and job creation in his community by launching his own agricultural operation: "I want to be involved in this [traditional] agriculture… for myself, and for all of us… I want to create jobs for the young ones."

Barrier 1: Dust, Digging, and Fetching Water

In all three focus groups, participants described agriculture as highly physically challenging. Elizabeth explained that "when we think agriculture, we just think hard labor, like the spades and the fork, dust and all that." Pheladi agreed, saying: "When you talk about agriculture, everyone think about hard labor. Every time when we mention agriculture, the first

[10] As discussed later in this section, many participants believe that a lack of entrepreneurial knowledge prevents aspiring entrepreneurs from launching sustainable, profitable operations.

thing that come in mind is digging." Keywords or themes that came up repeatedly when discussing traditional agriculture included dust, wind, working in the hot sun, digging, and fetching water, and it was clear that these associations had *negative* connotations.

Barrier 2: Lack of Institutional Support

Support and training opportunities related to agriculture or agricultural entrepreneurship were described as mostly non-existent. Participants were not aware of any non-profit organizations or businesses engaged in supporting rural agriculture. Johannes pointed out that he knows there is a Department of Agriculture where rural community members should be able to gain knowledge and ask for assistance, but he and his peers "are just in a rural village" and "don't have the knowledge to go out there and make it to the Department of Agriculture" which is located approximately forty minutes away in the provincial capital.

Participants from Mountain View and Masealama were not aware of any training opportunities available to members of their communities. One participant from Segwashi was aware of one person completing a food-related internship at a small nearby grocery store, but she was not sure what exactly the internship focused on. It was later clarified that this internship was not open to everyone in the village. In order to qualify, the man had to first be selected to be part of the government-sponsored Community Works Program, which aims to serve as a safety net to the poorest of the poor living in South Africa's marginalized communities. This qualifying criteria meant that, again, the vast majority of Segwashi community members did not have access to the opportunity.

Participants also discussed how, when training opportunities are available, corruption and nepotism often dictate who will be invited to take part. Moses said:

> *What I am going to say… it might sound political… the thing is the government will go to someone who is working closely to them and say 'go and do this and this and this so that*

> *we can find people to do this,' and then that person will select his or her own people… those who do not have even knowledge of that particular thing or are not even interested so that they can only find jobs.*

Other participants responded by vigorously nodded their heads in agreement, laughing, and saying that this kind of small-scale corruption happens "every day."

Participants were initially split in their opinions about whether or not community members would be interested in investing their own time or money in an agricultural training opportunity. While all of the Mountain View participants said they would be interested in attending such a training, none of the Masealama participants said they would be interested, and the Segwashi group was split roughly evenly. Thabang explained: "I think most of the people will take part because they know nothing. They are jobless. They are doing nothing at home." The participants from Masealama, on the other hand, said that the group of 'grannies' running the cooperative vegetable garden would be interested, but only a few young people would go. They suggested that young people are "lazy" and would prefer to stay home rather than spending their days learning about food production.

Barrier 3: Lack of Technical Knowledge

Some participants described traditional agriculture as appealing because they believe it requires less formal training and education than other professional fields. Thabang, the only participant to express a strong interest in agriculture at the beginning of the focus groups, explained his interest by saying:

> *According to my view, I think it is because I'm not educated. I don't have certificate for IT, for example… But for agriculture, I don't think you need, you don't need to be educated. Maybe you might need it a little bit, but not to spend a lot of money.*

Maggie echoed these sentiments, adding that agriculture is something you can undertake as a small, independent activity: “Working with agriculture, we don’t need any experience. You work on your own. You can start your own small garden and buy your own seeds.”

At the same time, participants agreed almost unanimously that a lack of knowledge serves as a major challenge to food production in their communities. Participants described this general lack of knowledge in different ways, but Pheladi summarized the general sentiment, saying “agriculture, it has a lot of opportunity, it’s just we are not experts to agriculture… that’s why maybe there’s not a lot of vegetables here.” Alice agreed, describing how people often don’t know which types of soil are best for which plants, and describing how people do their best to care for and water their crops, but they still die.

Taking these two seemingly contradictory views into account, the consensus seems to be that aspiring growers can engage in traditional agriculture with limited skills or knowledge, but they will likely do so with varying levels of success. Farmers who use traditional agriculture techniques often struggle with low-quality yields, low-quantity yields, or both. Traditional agriculture is seen as a logical personal endeavor on a subsistence level, but not an appealing income generating activity. More advanced knowledge and skills are needed to mitigate these challenges, allowing farmers to produce more efficient, reliable yields.

Barrier 4: Lack of Entrepreneurial Knowledge

In addition to a lack of knowledge and support related to growing vegetables, participants cited a lack of business knowledge as a main challenge to agricultural entrepreneurship. Alice stated that “starting a business, it needs patience and a love for what you are doing. And you must have, you know, a little background of how a business operates and you know, you have to know yourself what you are doing.” Khomotso said “I think from rural areas… a lot of people

don't understand a lot about entrepreneurship." Karabo agreed and expressed that she believes this lack of knowledge leads to slow results and a lack of motivation and persistence when it comes to starting a business: "The only problem around our village is knowledge. Like, they don't understand so many things, and when you try to explain to them, they just go. They want things quickly. They just want like quick cash. That's what they need."

Barrier 5: Water Scarcity

Water scarcity and soil fertility were the two most frequently cited challenges to agricultural activities. Dorcus stated "I think why we do not grow our own crops, it is because of water." Lina expanded on this statement, saying agriculture is dependent on "the rain" and "if there's no rain, they can't grow anything… and then sometimes they go to the river trying to get water, but still it's not enough for them." Marcus described how his uncle used to run a small farming operation that was dependent on taking water from a nearby school's water storage tank. The school eventually blocked access to the storage tank, leaving his uncle without a reliable water source, and he was forced to close his farming operation as a result. Elizabeth described how, even if growers have a reliable water source, it may be so far away that the effort required to get the water makes farming not worth the effort. She described this frustration like this: "We don't have water like close to us… So when you think about that wheelbarrow and… yo!... going there several times and you see that it is not enough… I have to go back… and then you think, yo!" Statements regarding water scarcity were almost always accompanied by passionate affirmations (nodding heads, saying "yes, yes" in agreement, etc.) from the other group participants, underlining the important role that water availability plays in the success of rural agricultural activities.

Barrier 6: Soil Infertility

Soil fertility was another often-cited impediment to agricultural success in each of the three rural villages. Tshepo stated "the reason why the vegetables become small in our village is because of the soil." Maggie said that "our soil is not fertile," and Alice stated "I think it's important, man, it is important… I think the soil is very important because we can't grow [inaudible] in the soil… that one I'm sure about." Nancy agreed that the soil is "trouble," explaining that she once tried to plant spinach and beetroot, but it all died because it was planted in infertile soil.

Interestingly, Karabo and Johannes actually believed that failures attributed to soil infertility should be attributed to a lack of knowledge. Karabo stated:

> *But sometimes the soil, I just think it goes according to how you plant your things. My mom does farming. We have spinach, it's fine; we do carrots, it's fine; we do beetroot, it's fine. I guess it's just according to how you just plant your things. Sometimes when you plant, they give you directions on how to do it and if you don't follow those sometimes it doesn't work.*

Johannes pointed out that there are solutions to soil infertility, but that the average person in a rural community does not know what those solutions are and is not able to access services like the Department of Agriculture for support.

Barrier 7: Land Scarcity

Interestingly, only two participants, both from Mountain View, brought up the challenge of land availability. Khomotso described the situation by saying "The problem is that, especially in this place- in our rural area- we're going to have the problem of the land, because I think it's already taken… not enough land." Nancy described how she used to buy food from inexpensive wholesalers, mark up the price, and sell it at a produce stand at the intersection of a busy shopping center. After a while, she realized that she was spending the majority of her revenue on

buying the wholesale produce as well as transportation to and from the wholesalers and shopping center. She was unable to mark up her prices any more without losing her customers, so in the end, she decided that the time and effort she put into the business was not worth the small profit it generated. She explained that she thinks she would have more success if she could grow her own produce to sell at the shopping center, therefore cutting out the cost of the wholesale produce as well as the cost of transportation to and from the wholesale center. She does not, however, have land where she could grow the vegetables and worries about how water scarcity and soil infertility would affect her operation.

Barrier 8: Crop Loss to Free-Range Livestock

Several participants described free-range livestock as a major challenge to rural food production. Marcus described how his uncle used to grow spinach, carrots, tomatoes, and other vegetables, but did not have a fence to keep grazing cattle from eating the crops. His uncle cut down trees and built a makeshift fence, but it was not strong enough to stop cows: "you can't stop cows… they come and eat it." Elizabeth described prior experience with planting and maintaining a small subsistence garden, but she abandoned these efforts after one growing season. She described how a major factor in her decision to discontinue her home garden was animals eating her crops. She said "I don't have a secure fence, so maybe that's why it's killing me, because the animals will always come in... so that would be maybe two steps forward and ten backwards."

Barrier 9: Lack of Startup Capital

When asked what challenges come to mind when thinking about agriculture, Thabang responded "I'm still standing by lack of support… money… money or support in the form of fences, machines for pumping water… pumping machines for pumping water at the river… and

other equipment." Phillip was also concerned with the lack of monetary support/startup capital available to rural young adults, citing in particular the high cost of necessary fertilizers and pesticides, as well as the high cost of transportation to get to and from cities where these products are available: "We have to go and buy fertilizers somewhere at Polokwane or Tzaneen, so it's difficult if you don't have a car… you have to pay for transport… you spend too much." Participants agreed that the average young person living in a rural village will not have the capital to purchase the inputs and equipment needed to engage in commercial agriculture.

Barrier 10: Competition

Participants were also concerned that competition, both with other small operations inside the village, as well as large-scale industrial operations outside the village, would impede attempts at agricultural entrepreneurship. To illustrate potential issues stemming from competition within the village, Alice described how she once ran a small entrepreneurial enterprise selling lunches, snacks, and candy to students at local schools. She was successful at first, but then two other people in the community launched similar operations. The village, and therefore market, is small, and she lost so many customers to the new businesses that she had to close down her business.

When considering outside competition, Kgopotso questioned how members of her community are supposed to compete with "the white people" or "the Guptas" (a notoriously wealthy and powerful business family in South Africa) who have already-established businesses that are able to offer products and services at a cheaper price. Karabo described how local community members prefer to buy from these outside competitors because they do not take local small businesses seriously. This is a problem because the majority of people living in rural areas

are living in poverty and do not have the startup capital to launch large-scale businesses. She described the problem like this:

> *People won't take you seriously. You will not get the support you need from the people around the village… you cannot just start a business with like, 1,000 rand, especially in rural areas, no. You just have to start by 50 rand and it goes 100 rand, but ah ah, they aren't going to help you if you just start with 50 rand. They won't. That's the problem we have.*

Johannes suggested that outside competition discourages rural dwellers from engaging in agriculture, saying, "For an example, I could plant tomatoes and [inaudible] in my yard. People could just go to the towns to buy tomatoes and my tomatoes start to be rotten. That would discourage me to start this business." Phillip shared Johannes's concern, saying:

> *I think it's risky. I mean, like, what if you plant something and people don't buy? Where are you going to take those foods of yours because you cannot eat the whole garden… it's a small village. If people don't buy your foods, where will you take them? You'll just have to throw them away, so you end up losing.*

Barrier 11: Lack of Community Support

Nuances surrounding the theme of local community support as it relates to traditional agriculture were particularly complex. During the initial discussion about traditional agriculture, several participants discussed how community members do not support one another's businesses, but prefer to buy from vendors outside the village instead. Participants attributed this trend to several different factors: 1.) Karabo's point about local community members not taking small-scale businesses within the village seriously is relevant here. She believes that community members prefer to give their business to more established large-scale businesses, even if they are located outside the local village. 2.) Karabo also attributed this lack of community support to the higher quality of produce in established grocery stores outside the village, saying:

> *You see, like, in the Shoprite and those, they are using fertilizers just to make those tomatoes be big. And you are selling, you did a traditional… they are just too small, they won't buy it. They need the big one. It's the quality.*

3.) Thabang believed the lack of community support could be attributed to the lower cost of produce outside the village; 4.) Elizabeth believed that buying from neighbors is simply not part of their culture and that people "don't really dwell on it that much."; and lastly 5.) Thabang and Kgaugelo attributed this trend to jealousy, with Thabang saying: "It's sort of like… I won't say it's like black mentality because it would be kind of offensive, but that's how it is. Black person, he doesn't want to see you going up. It's jealousy."

Barrier 12: Risk of Natural Disasters

Phillip from Masealama, the only participant with commercial agriculture experience, cited natural disasters as a major concern. He mentioned how the temperature in his village (which is sometimes very cold, causing frost) can ruin crops. He also described how a hailstorm had recently destroyed a commercial cabbage crop his company planted in March, meaning they were only able to start selling their product in September, five months after the initial planting. The other participants did not contribute additional opinions about the risk of natural disasters, but it is possible this omission may be attributed to their lack of commercial growing experience.

Key Themes - Controlled-Environment Agriculture

None of the 17 participants were familiar with the concept of CEA prior to taking part in the focus groups. Maggie said that this concept was so foreign, she did not realize that CEA would even be considered agriculture. After reviewing the educational handouts and watching the introductory videos demonstrating various hydroponic and aquaponic operations, participants responded with excitement, fascination, and a general renewed interest in agriculture. Elizabeth captured the sentiment of the participants best when she said:

> *It's kind of fascinating, but then I think if I were to explain it to someone who didn't see the video, it would come across as if I'm crazy… because it's so unreal in our minds if you don't actually see it happening or if we don't really read about it or something like that. But it's fascinating… like no one can ever think you can grow something in [a*

> *container] and then like vertically, so no one would have thought about it like around here. And all we knew was you can actually help chicken grow with lightbulbs. That I knew. But I never really thought that it would happen with plants… Maybe some of us are not interested in agriculture because we don't know how things are done. We were not exposed to this method of growing things.*

Participants thought that if young people in their communities were simply more exposed to different agricultural methods such as CEA, overall interest in agriculture may increase. After being introduced to the concept of CEA, Pheladi stated, "I didn't have that interest [in agriculture] then but I am interested now."

Opportunity 1: Reduction of Hard Labor

Participants' positive reception of CEA can be largely attributed to their belief that CEA would involve less 'hard labor' than traditional agriculture. Elizabeth clarified that with CEA, "you don't have to clean the garden, you don't have to be having to have a fork and spade all the time, and watering cans and all that." Participants were attracted to the idea of CEA being done in an enclosed environment, rather than outdoors, and were particularly struck by the possibility of growing produce without soil, vertical growing, and the faster gestation periods possible with CEA. Karabo believed that CEA enterprises would "work for [young people] because, like, most of the youth nowadays, we are lazy… I am lazy… and it doesn't need hard work. Like, it's simple. You just get the water, the nutrients, it's simple… You don't have to get tired or anything, so it will work for me." Participants from all three groups gravitated towards the simpler method of dutch bucket hydroponics demonstrated in the first video and described the Cape Town aquaponics operation introduced in the third video as complicated and intimidating.

Opportunity 2: Economic Benefits

Participants strongly believed that CEA would generate wealth in their communities. Johannes said "we don't have money… I just think about money… like, this thing, it will help

me to get money." Thabang felt that with CEA, "you can increase, triple your income." Alice felt that CEA would be worth the initial financial investment, saying "it's fast and even if you spend a lot of money starting this, but in years to come or months to come, that money will feed back to you in time." Elizabeth was even more optimistic, saying that CEA "would uplift this community to the next level" and "if you go about it the best way, then I mean, you're a millionaire!" The participants from Masealama were particularly interested in the possibility of using CEA to grow fodder for cattle, believing that a business with two streams of income (vegetables and cattle) would be especially profitable. Some participants also believed that, because they see CEA as "simpler" than traditional agriculture, a CEA system would require less time, and therefore leave the grower with more free time for other activities, which could potentially be income-generating activities to further increase their wealth.

Interestingly, while participants unanimously believed that CEA would generate wealth in their communities, not everyone believed this wealth would translate into increased job opportunities. Phillip and Elizabeth felt that CEA operations are actually *too* easy and devoid of manual labor to warrant hiring any employees. Phillip explained his feeling by saying: "I don't think someone using this method can hire a lot of people, I don't think so… you can do it yourself." They concluded that while the owner of a CEA enterprise may increase his or her own wealth, that wealth may not be spread throughout the village.

Opportunity 3: Environmental Factors: Water Use, Soilless Growing, and Vertical Growing

Participants were impressed by the amount of water CEA saves compared to traditional agriculture. Thabang talked about how CEA is "a good thing" because where a traditional agriculture operation may require 10 water storage tanks, a CEA operation producing the same amount of food could theoretically only require one. Elizabeth agreed: "The amount of water you

save… it's amazing." Alice, who previously expressed concerns related to soil fertility and soil knowledge among growers, was impressed by CEA's ability to remove this challenge: "It has taken agriculture to the next level… you don't have to worry about the types of soil and all those types of things." Wilheminah agreed, saying CEA "is interesting for us because you don't need the soil, so it's good." Elizabeth was also surprised and impressed by "the fact that you can have your plants vertically" when using CEA. Thabang identified CEA's efficient use of land as a key motivator for his interest in engaging in CEA: "It requires small space… it's good… I want to have it."

Discussion surrounding the topics of water, soil, and land as they relate to CEA were short and succinct for all three groups, but nevertheless of obvious importance to the participants. This was evident in participants' silent or monosyllabic responses (such as fervent head nodding or simply saying "yes" in agreement) to comments made by other participants regarding these topics. It felt like these statements were so obvious that they required no elaboration or additional discussion. Participants were asked several times throughout the discussion if anyone wanted to express disagreement with statements made by other participants, and no disagreements regarding CEA's more efficient use of water, land, or soil were brought forward. The general consensus was that CEA would be helpful in combatting the main environmental challenges afflicting traditional agriculture.

Opportunity 4: Shorter Gestation Periods

CEA's ability to grow produce in less time than traditional agriculture was a key point of interest for several participants. Moses described CEA as "more progressive and productive" while Marcus said "it's not every day your fruits and vegetables are produced within a short time and in twice the amount… I think it would make a big difference." Johannes was particularly

impressed by the fact that one of the farmers in the video could produce beds of fully-grown fodder in only six days, which could then be used to feed pigs, goats, chickens, or cows. Maggie was also interested in this link between CEA and animal farming, commenting on how she was surprised that hydroponically grown fodder allowed the same farmer in the video to grow his pigs to be sold at market in only six months.

Opportunity 5: CEA as a Learning Opportunity

Some participants saw bringing CEA to their communities as a learning opportunity for local community members. Jurita described how most people in her community don't think about how food is grown: "they just see the tomatoes there, they don't care how the tomato ended up being a tomato." She sees CEA as an opportunity to educate those around her on the science of food production. Elizbeth believed that introducing CEA would "enlighten people," while Moses said that practitioners of CEA can use it as "an opportunity to expand themselves."

Barrier 1: Specialized Knowledge and Skills

When asked what challenges may hinder CEA operations, Pheladi said potential practitioners "need the skills, the knowledge of how to do this." The challenge of acquiring knowledge and support was discussed in connection to traditional agriculture, but it was mentioned more often and with greater concern when discussing CEA. While participants may find traditional agriculture outdated, boring, and inefficient, they are all aware of at least a few local people who engage in traditional agriculture and can share knowledge. These practitioners of traditional agriculture would likely benefit from greater levels of institutional support and knowledge of updated methods, but they have at least basic skills that allows them to produce food with varied levels of success. These skills have been passed down and around for many generations, creating a local network of support. This is not the case with CEA, which

participants believe would be a completely new concept to everyone in their communities. Johannes pointed out that "here in Segwashi, we don't have a specialist… it would be a challenge." Participants were particularly concerned with the challenge of correctly using hydroponic nutrients. Moses said:

> *For me, the challenge would be nutrients… because, I understand that those plants, you can grow them in water without using soil, but they still need their nutrients, so you'll have to buy them… and some of us… they may not know which ones are correct for which plant.*

Barrier 2: Lack of Startup Capital

Another challenge identified as affecting both traditional agriculture and CEA was a lack of startup capital. Participants saw examples of CEA operations of varying complexities, from a simplistic (inexpensive) dutch bucket operation to a high-tech aquaponics farm. While participants gravitated towards the more simplistic dutch bucket operation, even this would require basic containers, an enclosed structure or at least a roof, hydroponic nutrients, seeds, and some kind of growing medium in which the seeds could grow. Participants felt that they would not be able to cover these initial costs on their own. When asked what challenges may affect CEA operations in their communities, Johannes said "the cost" while Pheladi agreed: "For this thing, you must have money." Thabang was inspired to launch his own CEA operation as a result of the focus group, but felt that he would need to secure funding before he could be successful: "I'm thinking to start it… I'm going to look for funds... Many people who have money, maybe they will be able to help me." While the components of a basic dutch bucket operation may be inexpensive compared to more complex systems such as aquaponics, it is clear that the necessary capital would still be a barrier for average young adults living in rural communities in Limpopo.

Barrier 3: Logistics

Participants identified logistics as a challenge affecting CEA, but not traditional agriculture. Specifically, participants expressed concerns about how and where to buy the required nutrients. Thabang asked "where do I get nutrients?." Alice agreed, saying that finding "the nearest place where they can find the nutrients" would be a challenge. The consensus seemed to be that sourcing the correct nutrients is a make-or-break challenge, but with a potentially simplistic solution. Either they can find somewhere to source the nutrients, in which case, the problem is solved, or they cannot, in which case, engaging in CEA is no longer a possibility. Elizabeth explained it this way: "We would just have to worry about the nutrients, which if you know where to get them, it's not going to be a worry, so no stress."

CEA's Uncertain Impact on Food Security

It is interesting to note that none of the 17 focus group participants mentioned increased food security as a potential benefit of CEA. They focused instead on CEA's ability to solve environmental challenges, reduce hard labor, and generate wealth. As discussed in the *Traditional Agriculture- Key Themes* section, participants did see increased food security as a benefit of increased agricultural activity in general. Silence on this topic could be taken to mean a few different things: 1.) Participants do not believe that CEA has the potential to increase food security in their communities; 2.) Participants believe that CEA may increase food security, but did not find it important enough to discuss, unlike wealth creation or the reduction of hard labor; or 3.) Perhaps participants felt it went without saying that, if the introduction of CEA increases the amount of agricultural activity in their communities, food insecurity would be addressed in the same way they already discussed in the *Traditional Agriculture- Key Themes* section.

Without further information, this study cannot draw any concrete conclusions about how young people view the relationship between CEA and food security.

CEA's Uncertain Impact on Community Support

As discussed in the *Traditional Agriculture- Key Themes* section, participants expressed a variety of opinions about why rural businesses struggle to gain local community support. Participants believed that community members' buying preferences are affected by quality, price, size of business, culture, and jealousy. Interestingly, after being introduced to CEA, several participants changed their stance and said that their neighbors would support a CEA enterprise. When probed to explore this topic further, participants revealed that they believe community members would support CEA enterprises if they are able to produce a more stable, plentiful, and high-quality yield when compared to traditional agriculture. Karabo, previously concerned with the quality of locally-grown produce, said: "Because everything, the plantings, they look fresh. The results are good, so they look at the results, not the hard work involved… as long as they see that the spinach is like fresh, the leaves are big, they're gonna buy." Participants also believed that when a local business appears reputable and stable, community members will support it. Thabang described it this way: "I think they going to buy because you will always have enough vegetables… they can see that this man is serious yeah this man is serious and he produces many vegetables." Thabang also believed that the novelty of CEA would attract a wide customer base, saying: "This thing, they are going to be amazed… They will want to buy… They're going to see this type and want to taste it."

Other participants, however, thought that community support would continue to be a problem. Johannes thought that CEA may actually be *too* novel for older community members, who may believe "sangomas," or local witch doctors, are helping to grow the produce

supernaturally. He elaborated by saying: “It requires more old people… like this technology… they will think ‘how?’ They will start to think but how this man could just plant things with seeds… they are going to buy from [a large grocery store outside the village] because they think you are going to poison them.”

All four participants from Masealama agreed that neighbors would not support a local CEA business, though reasons for the variance between Masealama and the other two villages on this topic are unclear. Pheladi thought it would be difficult to sell produce to neighbors, but that CEA operations could still be successful because “you still can sell to other people outside Masealama.” Elizabeth agreed, suggesting that produce could be sold at road-side stalls outside the village. She also believed that external exposure could lead to other opportunities, such as supplying produce for special events. She said “people out there would know, alright, there is someone here. If they have functions, they will come to you.” Pheladi and Elizabeth also pointed out that support for local growers would be affected by which fruits and vegetables are produced. If traditional foods such as cabbage, tomatoes, and peppers are grown, local community members may buy them. But if lesser known vegetables such as lettuce and cucumbers are grown, community members won’t know how to prepare them, and therefore, will not buy them.

DISCUSSION

There are a few key takeaways we can draw from the data. It is clear from the results that young adults living in rural villages in Limpopo consider, whether consciously or unconsciously, a large number of factors when deciding whether or not to engage in traditional agriculture. Study participants identified a few key opportunities related to traditional agriculture (potentially increased food security and economic benefits), however, they identified far more challenges. The challenges young adults associate with traditional agriculture can be categorized under four main headings: Perception of Traditional Agriculture as Hard Labor; Perception of Traditional Agriculture as Unprofitable; Lack of Capital; and Lack of Knowledge and Support. Each of these challenges constrains one of two things: young adults' *interest* in engaging with traditional agriculture or young adults' *access* to engaging with traditional agriculture.

The result of these *Barriers to Interest* and *Barriers to Access* is low agricultural engagement levels among young adults (as discussed in the *Participant Engagement with Agriculture* section on page 40). Those who do not want to engage in traditional agriculture (8/17 study participants) are discouraged by *Barriers to Interest.* Those who are willing, but are not able, to engage in traditional agriculture (7/17 study participants) are discouraged by *Barriers to Access.* The results of this study show, after being introduced to the concept of CEA, participants believe CEA has the potential to address *Barriers to Interest* by reframing the way they associate agriculture with physical labor and profitability. However, they do not believe that CEA, in and of itself, has the ability to address *Barriers to Access*, which would need to be addressed using a holistic approach in order for any CEA-centered development initiative to be successful.

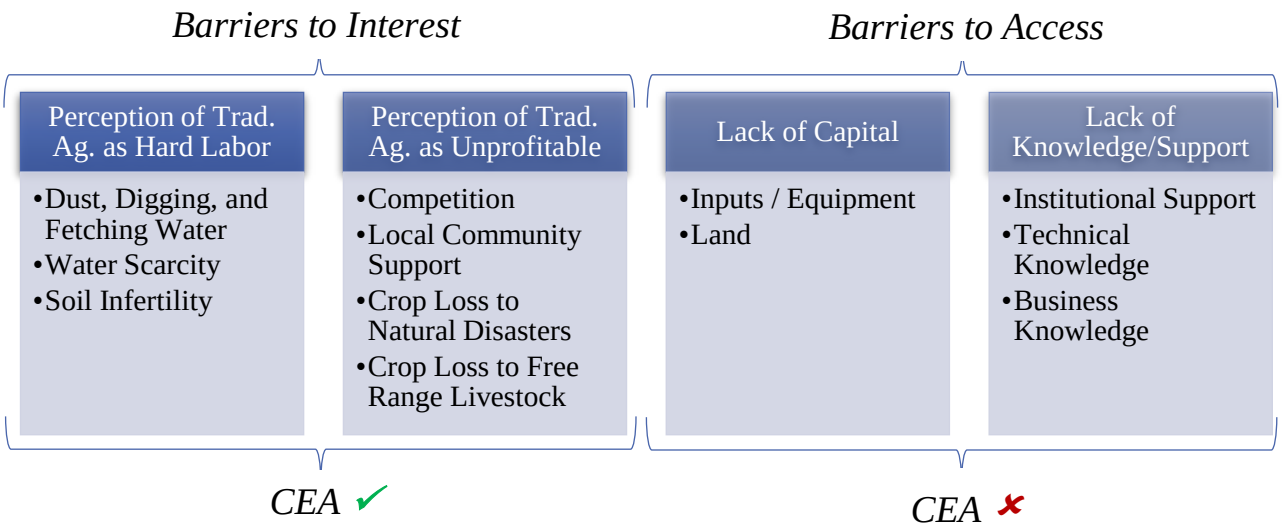


Figure 3: Barriers to Interest and Barriers to Access

Barriers to Interest

Participants' interest levels were dampened by the perceived low profitability and productivity of agricultural activities. During initial discussions, when participants were asked what opportunities they associate with traditional agriculture, only three of the eighteen participants mentioned economic benefits. It is also important to note that there was not a strong sense of agreement or nonverbal support from the other participants in relation to these statements. Participants discussed how unreliable market access and crop loss to free range livestock and natural disasters make commercial farming a risky activity. One could conclude, therefore, that most participants do not strongly associate productivity and economic benefits with traditional agriculture.

This in and of itself does not illustrate the important role that profitability plays in determining interest levels, however, when analyzed in conjunction with participants' responses to CEA, the relationship becomes clearer. Wealth creation was the second most-cited benefit of

CEA according to study participants. Participants cited higher-quality produce, faster gestation periods, increased local community support, and protection from cattle grazing, among other factors, as determinants of CEA's increased productivity and profitability. When describing the economic benefits they associate with CEA, they used phrases such as "triple your income," "make money two times faster," "you can be rich," and "unemployment would be a thing of the past." There was a strong association between profitability and CEA, and it was clear that this relationship generated excitement and had a positive effect on the interest levels of participants.

This positive relationship between youth interest levels and perceptions of profitability agrees with available literature. The consensus among major international development agencies is that young people in Africa become interested in agriculture when it is shown to be productive, profitable, and dynamic (Agriculture for Impact, 2014; Brooks et al., 2013; Cassinath et al., 2016; Filmer et al., 2014; Food and Agriculture Organization, 2013; YouthPower, 2018). More specifically, very poor young people want to engage in activities that provide "quick money," something not typically associated with agriculture (Cassinath et al., 2016). A Feed the Future project found that Guatemalan youth were enticed to participate in the agriculture sector by selling inputs to village farmers, providing a more immediate payoff than growing and selling food. (Cassinath et al., 2016). The same project found that Liberian youth preferred the shorter gestation periods and faster payoffs of horticulture to seasonal staple crops (Cassinath et al., 2016). Similarly, the participants in this study were drawn to the shorter growing cycles and potentially increased profitability of CEA when compared to traditional agriculture.

While participants' interest in profitability fits with available research, their acute dislike for manual labor appears unique. Participants' perception of traditional agriculture as 'hard labor' was perhaps the most consistent and clear take-away from the study. Environmental

challenges such as water scarcity and soil infertility, which require farmers to haul water over long distances and till hard ground, undoubtedly contribute to their perception of traditional agriculture as hard labor. Words and themes such as "digging," "dirty," and "fetching water," were used repeatedly throughout the group discussions related to traditional agriculture. Participants self-described their generation as "lazy" and said that, generally speaking, they prefer to engage in work that is less physically rigorous, such as administrative office work. Conversations surrounding the idea of agriculture as "hard labor" generated a great deal of animation and nonverbal agreement among participants, underscoring the important role this concept plays in their understanding of agriculture. In contrast, when describing initial perceptions of CEA, participants used words such as "simple," "easy," "fast," and "convenient." This perceived simplicity was cited as a benefit of CEA more than any other factor, suggesting that young people view the work required by CEA more favorably than the work required by traditional agriculture, and that this distinction greatly influences their interest levels.

This distaste for hard manual labor is not well represented in other literature. Whereas other studies seem to conclude that young adults are willing to engage in manual labor if it is financially rewarding, the participants of this study very clearly communicated that agriculture needs to be productive, profitable, *and* easy for them to engage. Additional research could be undertaken to explore what social constructs, cultural norms, or other factors are present that may lead participants from this study to have a more negative perception of manual labor when compared to peers from other similar studies.

Results from this study also contradict mainstream development wisdom when it comes to the relationship between youth interest levels and technology. As Cassinath et al. point out, organizations and agencies promoting youth agricultural initiatives often mistakenly believe that

modern mobile technologies or expensive inputs are needed to entice youth to agriculture. Most, however, are enticed by simpler and more accessible solutions such as improved seeds, climate-smart management techniques, and basic irrigation systems (2016). The results from this study support Cassinath's point. While participants were interested in learning about new and innovative growing techniques (e.g.: growing crops without soil), they were intimidated by more technically-advanced techniques such as aquaponics. They were drawn instead to the simpler method of open-air dutch-bucket hydroponics, which requires no light bulbs, timers, or electricity.

Barriers to Access

Participants who were interested, but not currently engaged, in traditional agriculture, discussed being hindered by two main barriers to access: 1.) A lack of startup capital; and 2.) A lack of knowledge and/or support. These findings are partially consistent with available literature, which consistently concludes that finance, skills, and land are the top three barriers preventing young people from engaging with agriculture (YouthPower, 2018).

Participants from this study believed that successful traditional agriculture operations require startup capital for inputs including fences to keep animals out, fertilizers to improve the quality of the produce, pesticides to protect against damage from insects and disease, and sometimes water pumps to provide a stable water source. Young adults in rural communities in Limpopo experience extremely high levels of poverty and do not have the capital needed to cover these costs. Without the capital to purchase basic tools and inputs, they are unable to take the first steps towards engaging in traditional agriculture. The financial challenges that youth face when attempting to engage in agriculture have been widely documented in other studies (Brooks et al., 2013; Hamp et al., 2015; Nourse, 2016a, 2016b; YouthPower, 2018). A range of

financial services including youth savings groups, matching grants, microloans, traditional loans, and mobile banking, in conjunction with financial literacy training, have been suggested as solutions to the financial exclusion of youth, with varying levels of success in different settings (Brooks et al., 2013; Hamp et al., 2015; Nourse, 2016a, 2016b; YouthPower, 2018). Participants in this study did not see CEA as a solution to their lack of startup capital. At minimum, young adults interested in engaging in CEA would need to secure containers, a growing medium, seeds, nutrients, and preferably some kind of enclosed structure to get started. Without access to startup funds to cover these costs, they expressed concerns about being able to launch or maintain CEA operations.

Participants also believed a lack of skills and knowledge would constrain their ability to successfully engage in agriculture. Limited knowledge and skill sets prevent them from navigating both technical challenges (soil infertility, low quality yields, etc.) and entrepreneurial challenges (financial management, market access, etc.). Institutional safety nets that could help them address these challenges, such as government extension offices or NGOs, are either inefficient or inaccessible to participants, leaving them feeling overwhelmed by the prospect of navigating these challenges alone. These findings support the available literature, which consistently agrees that a lack of skills is one of the top barriers preventing young people from engaging in agriculture (YouthPower, 2018). Other studies have concluded that skill building initiatives have positive impacts on youth employment and income, especially through hands-on initiatives such as farmer field schools and employer-based training (YouthPower, 2018). Some argue that too much public investment in agriculture has gone to short term solutions such as fertilizer subsidies, and that efforts to invest in long-term solutions such as research and training must be emphasized in the future (Brooks et al., 2013). As with the challenge of startup capital,

participants did not feel that CEA would serve as a solution to the challenge of acquiring appropriate skills and knowledge. Young adults interested in CEA would need to know how to deliver nutrients to the plants and in what quantities, where to get hydroponic nutrients, which nutrients to use with which plants and in what quantities, etc. In addition, because the rural villages where participants are located have no local CEA practitioners, they would be at an even greater disadvantaged when compared to traditional agriculture, which is practiced by at least a handful of local people from whom they could draw basic information and support.

The results of this study are less clear when considering how participants are affected by land scarcity. Available research suggests that land scarcity due to the legacy of apartheid, inefficient rural land tenure systems, and unfavorable ecological conditions would make land scarcity a major issue preventing these participants from engaging in agriculture (Cassinath et al., 2016; Clover & Eriksen, 2009; Hoeks, 2014; Plott, 2009; Vink, 2009). Two participants form this study cited land scarcity as a constraint they face, suggesting that their lived experiences match the available research. However, it is important to note that the two people who cited land scarcity as a challenge were both from the same village (Mountain View), and that the comments on this topic were brief and met with little interest from other participants (as measured by a lack of affirming body language or follow-on comments). No participants from Segwashi or Masealama mentioned land scarcity as a potential constraint. This may suggest that land is more available in these communities than in other locations in Africa. It may also suggest that land is a constraint, but not as pressing as startup capital and training. Additional research focused on land availability and tenure systems in this specific region may help draw conclusions about how land constraints may or may not affect youth wishing to engage in agriculture.

Implications

In agreement with available literature, the results of this study suggest that young people become interested in agriculture under the right conditions. Participants expressed a great deal of excitement about CEA, as well as an increased willingness to engage in CEA activities as opposed to traditional agriculture activities. They are optimistic about CEA's novel growing techniques and its ability to solve some of their communities' greatest agricultural challenges, including water scarcity and poor soil quality. This positive feedback suggests that investment in CEA initiatives would have local buy-in and engagement from beneficiaries, one of the most important determinants of success for any development initiative. If this heightened interest could be harnessed, and young adults could be equipped with the tools necessary to successfully produce food using CEA techniques, positive outcomes could include more rural youth engaged in meaningful and rewarding work; increased income and wealth generation in rural communities; increased food production using less water and less fertilizer; increased food production on smaller plots of land; and increased amounts of fresh produce available in rural communities.

Based on these findings, the researcher recommends that key stakeholders[11] in the development field consider investing in holistic CEA-centered development initiatives by offering targeted training opportunities and ongoing support to young adults in rural villages in

[11] Implementing stakeholders could include South African government extension offices, universities, international NGOs, or local NGOs. As an example, the University of Limpopo (UL) may have the interest and capacity to invest in CEA-centered development initiatives. UL is located in the Polokwane Municipality and has a School of Agriculture and Environmental Services that houses an Aquaculture Research Unit, the Syferkuil Experimental Farm, and a Centre for Rural Community Empowerment (University of Limpopo, 2017). It may be appropriate to conduct a community asset evaluation in targeted regions to identify potential implementing organizations.

South Africa. To more accurately evaluate the effectiveness of such an endeavor, it may be worthwhile to first conduct a randomized controlled trial modeled after the work being done at MIT's Abdul Latif Jameel Poverty Action Lab, in which treatment groups who take part in the initiative and control groups who do not are evaluated against one another (Banerjee & Duflo, 2011). The question then becomes, if such an initiative were to be designed, implemented, and evaluated, what would it look like? What characteristics would increase its likelihood of success? Participants in this study were clear that additional constraints related to startup capital and skills development would need to be addressed before they could successfully engage in CEA, meaning that potential development initiatives would need to be robust and dynamic, going far beyond surface level activities that only provide information or technical training. Drawing from insights found in this study, as well as related literature, the researcher has outlined a suggested framework of characteristics that could increase the likelihood of success for CEA-centered development initiatives. Corresponding 'next steps' that may help move the discussion from theory to action are also included, where appropriate.

Suggested Framework for CEA-Centered Development Initiatives

Figure 4: Building blocks of a successful CEA-centered development initiative

Stakeholder Engagement

Development initiatives are more likely to succeed and result in positive long-term outcomes when stakeholders are engaged in every step of the planning and implementation process (Banerjee & Duflo, 2011; Cassinath et al., 2016; Consortium of International Agricultural Research Centers, 2012; Easterly, 2007; Polak, 2008). Interventions should prioritize consulting with rural young people, understanding their motivations, and tailoring activities and desired outcomes to fit their needs. Youth beneficiaries need to be the drivers of any potential CEA initiatives.

Appropriate Technology Design

Consistent with the available literature, participants from this study are concerned with quickly making a profit from entrepreneurial endeavors, meaning it is unlikely they would choose to invest time and energy into developing their own CEA systems from the ground up. For this reason, initiatives should consider providing and training participants on uniform fully-functional CEA kits that will allow participants to immediately gain hands-on experience and generate income. The kits could be modular to allow participants to increase the complexity and functionality of their CEA systems as they increase their skills. The system(s) should be innovative but low-tech, resulting in a design that is more affordable and less intimidating to potential participants. Lastly, all potentially necessary replacement parts should be locally available and accessible (Consultative Group for International Agricultural Research, 2012). Inspiration for the design(s) could be drawn from the work being done at Hydroponics Kenya, Ltd., a commercial operation that designs and installs simplified hydroponics systems for low-income farmers (Securing Water for Food, 2017).

- *Suggested Next Steps*: Determine if an appropriate CEA system is already commercially available and cost-effective. If not, design and test prototype systems in a limited number of target communities. Because the final system design(s) will inform several other pieces of the project, such as minimum land and education requirements for participants, it is suggested that this step be tackled first.

Effective Recruitment

Attracting the right candidates who are likely to find success as CEA practitioners would be of the utmost importance. Initiatives should evaluate what characteristics participants will need

to be successful, and define minimum selection criteria including age, location, professional experience, and education levels. Setting minimum literacy and numeracy skills based on the required learning content, and then ensuring participants have these minimum skills through an entrance exam, would help ensure selected participants can fully engage in learning materials and achieve learning outcomes.

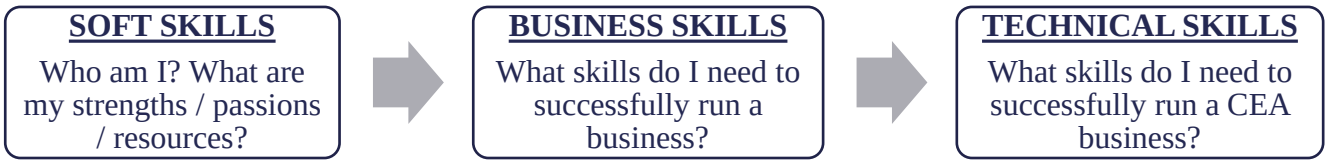
Recruitment plans should also consider that young adults in target rural communities will likely have no prior knowledge of CEA. Participants in this study were not excited by the concept of CEA until after it was introduced through pictures, diagrams, videos, and discussion. Therefore, the concept of CEA, its methods, and potential benefits should be advertised *before* official recruitment efforts begin to increase interest in the program and increase the possibility of recruiting the most qualified candidates. These marketing efforts should be done in-person in the village(s) where the program will take place, as opposed to through written materials alone, to allow interested applicants the opportunity to ask questions. The use of videos and pictures to educate participants on CEA methods is particularly helpful.

- *Suggested Next Steps*: Determine minimum education levels needed to operate the selected CEA system. Evaluate typical education levels of beneficiaries in target communities. Perhaps evaluate what low-literacy and pedagogy tools are available to serve beneficiaries with low education levels. Determine a final set of minimum education levels and other qualifications.

Appropriate Solutions to Knowledge Constraints

Participants from this study were clear that receiving effective training would be critical to their CEA microenterprise success. They cited both technical skills (knowing how to administer nutrients appropriately; how much water to use for each plant; etc.) and enterprise skills (how to

successfully run a business) as major constraints. Available literature on youth development initiatives across Africa have consistently found that developing 'soft' skills (critical thinking, communication, organizational skills, etc.) and being sensitive to psychosocial factors that may impact participant success is equally important (Cassinath et al., 2016; Hartnack, 2013; DG Murray Trust, 2012; YouthPower, 2017). The DG Murray Trust, a leading development organization in South Africa, found that participants in its Activate! youth leadership program often need to unpack and come to terms with past trauma before being able to successfully focus on personal and professional growth (2012). To appropriately address knowledge constraints, effective CEA initiatives will place equal emphasis on developing the soft, technical, and business skills of its participants.



- *Suggested Next Steps*: Conduct secondary research, drawing on publications and reports from leading development organizations working with youth in Africa, to develop an in-dept understanding of best practices in youth development training programs. Assess what technical CEA skills participants will need based on the final CEA system design. Develop an appropriate mix of learning sessions complete with learning activities and outcomes.

Appropriate Solutions to Financial Constraints

Providing participants with uniform fully-functional CEA kits and high-quality multifaceted training will require a financial investment. Participants may also require funding to cover costs related to transportation, product storage, marketing materials, etc. Poor rural youth

lack startup capital for entrepreneurial endeavors and struggle to access financial services on their own, so it is unlikely participants would be able to raise enough capital to cover necessary business expenses on their own. Successful CEA initiatives will need to help participants solve these financial constraints. But how? Should initiatives give the CEA kits to participants as an in-kind grant with no expectation of repayment? Should they instead serve as a bridge, connecting rural youth to already-established financial services they may not be aware of?

Available literature supports several solutions to youth financial exclusion, including providing cash grants, providing in-kind grants, trading financing for community service hours, launching youth savings groups, financing or connecting participants to microloans, and connecting participants to formal financial services (bank accounts, traditional loans, etc.) (Brooks, 2013; Cassinath, 2016; Hamp, 2015; Hartnack, 2013; Nourse, 2016a). Several studies have found that integrating financial services (grants, loans, bank accounts, etc.) with non-financial services (financial literacy training) increases the likelihood that youth will be able to operate successful microenterprises (Brooks, 2013; Hamp, 2015; Nourse, 2016a).

Based on these findings, it is suggested that successful CEA initiatives should place a high priority on working with participants to design the right combination of financial and non-financial services to provide participants with the financial security they need to grow into successful business owners.

- *Suggested Next Steps*: Evaluate the financial literacy level of target participants and design targeted non-financial services trainings to fill the gaps. Estimate the amount of funding needed to cover necessary business costs for each participant. Evaluate the most promising financing options. Some relevant questions may include: Are there traditional financial services available that participants simply need to be connected to? Could the

primary implementing organization partner with an already-established financial institution or microlending agency to provide the necessary funding that participants would pay back? Would direct grants with no expectation of repayment be more effective? What does the literature say about what rules, checks, and balances need to be in place to increase effectiveness of direct grants? Would participants be interested in forming a savings group to invest in their financial futures?

Appropriate Solutions to Land Constraints

Participants will need access to land where they can set up their CEA systems. The final design of the CEA kit would determine how much land is needed for each kit. The way in which potential land constraints can be addressed may be highly dependent on who the implementing stakeholder is. Local stakeholders such as government extension offices or universities may have more influence over rural land tenure systems, and perhaps the ability to secure land for program participants. More external players like NGOs, however, are unlikely to have any influence or control over land allocations in rural communities. In that case, the best course of action may be to require each applicant to have access to a certain amount of land as a minimum program qualification. The important thing is that implementers ensure that every participant has access to the land necessary for them to operate a successful CEA microenterprise.

- *Suggested Next Steps*: The results from this study leave unanswered questions regarding land availability and land tenure systems in rural villages in Limpopo. Participants' minimal comments on the subject may suggest that they do not see land as a major constraint, but it is difficult to draw any definite conclusions from the data. More in-depth research would need to be conducted in each targeted region to better understand local land tenure/constraints and design an appropriate response.

Robust and Multi-Faceted Program Design

Youth development work is complex, requiring a significant investment of time and resources to generate results (Cassinath et al, 2016). Literature on youth development programs in South Africa have concluded that successful programs will:

1.) *Offer robust services with multiple participant touch points*. Programs that include intensive in-person trainings, mentoring relationships, tutoring opportunities, sustained communication between participants, and referrals to additional support services are more likely to have positive outcomes than programs that incorporate only one or two of these elements (Hartnack, 2013).

2.) *Emphasize collective action and support*. Young people achieve more when they share a common goal, develop deep relationships with peers, build sustainable networks, and inspire, support, and learn from one another (DG Murray Trust, 2012; Jobson, 2014). DG Murray Trust explains its emphasis on collective action like this:

> *If we ask young people to run a community service project in their school, most will come up with the same old ideas. But what would happen, we wonder, if instead of asking "what project can each of you run in your own school?" to 150 individuals, we asked "what can 150 young people do to change the state of education?" It seems to us that we need to shift the focus to collaboration; working with the ideas young people have and pushing them towards being able to show significant impact.*

Within the agriculture sector, Feed the Future found that youth working in groups benefit from stronger bargaining and advocacy power, more advanced conflict resolution skills, greater resiliency, and economies of scale that allow them to aggregate harvests to sell bulk produce, negotiate better prices, and pay less for inputs (Cassinath et al, 2016). Strong group networks also help sustain results after a project ends.

3.) *Offer long-term support (Cassinath et al, 2016; DG Murray Trust, 2012; Morifi, 2017).* Given the low education levels and limited professional experiences of young adults in rural communities, as well as the historical lack of engagement in agriculture and the novelty of CEA methods, it is unlikely that participants would be able to master CEA methods and navigate the technical and economic challenges associated with operating a CEA enterprise without reliable long-term support.

4.) *Commit to dynamic implementation methods.* Projects need to expect the unexpected, stay flexible, and develop real-time reporting processes that allow leadership to understand what is happening on the ground and respond. Facilitators of DG Murray Trust's Activate! leadership program, for example, were initially unprepared for participants' stories of past trauma and did not know how to respond appropriately. Facilitators were able to communicate this challenge to leadership, who promptly took action by sending facilitators on a professional counseling course that prepared them to more effectively navigate these issues in the future (DG Murray Trust, 2012).

- *Suggested Next Steps*: Conduct in-depth secondary research, drawing on publications and reports from leading development organizations working with youth in Africa, to develop an in-depth understanding of best practices in youth development training programs. Develop an appropriate implementation strategy based on these findings.

CONCLUSION

This research project set out to better understand the attitudes and perceptions young people living in rural communities in the Limpopo Province of South Africa have towards traditional agriculture, CEA, and related training opportunities. Results show that participants expressed overall negative attitudes towards traditional agriculture. While they acknowledged its potential to increase food security and generate wealth in their communities, they were frustrated by the large number of challenges that constrain agriculture, making it labor intensive and financially risky.

Conversely, participants expressed generally positive opinions about CEA, which they believed has the potential to solve some of the most pressing challenges constraining traditional agriculture. CEA was a novel concept that generated excitement among participants. They believed that other young people would share their excitement and fascination and that CEA-centered training opportunities would have the local support needed to be successful. While participants were generally optimistic about CEA, they also acknowledged that CEA presents its own unique set of challenges.

The data suggests investment in CEA has the potential to reduce the hard labor associated with agriculture, generate wealth in rural communities, and get young people interested in agriculture *if* outreach efforts include long-term training/support, as well as funding to cover startup costs. While these findings are not generalizable to young adults in other geographic locations, they do contribute to the understanding of how rural young people perceive agriculture and how young people may respond to efforts to increase agricultural engagement through the introduction of CEA.

While the study produced useful data, it was also constrained by the following limitations, which should be taken into consideration before conducting further related research:

1. R50 was not enough to incentivize attendance for some of the selected participants, resulting in a smaller sample size and less collected data. It may be beneficial to increase the stipend amount for future studies to increase the likelihood that all selected participants attend the study.
2. Some participants did not accurately assess or report their English language skills. (i.e.: Some participants stated they had 'strong' conversational English skills on their application form, when in reality, they had poor conversational English skills.) Poor English skills among a handful of the participants resulted in low participation on their part, meaning that this study was not able to fully capture their thoughts and opinions. For future studies, it would be important to find a way to ensure that selected participants do, in fact, have the necessary language skills to contribute meaningfully to the discussion.
3. While conducting focus groups allowed me to successfully extract colorful personal stories, deep thoughts, and complex themes, I felt that utilizing only one research tool left gaps in the data, and that the study would have benefitted from a mixed methods approach. For example, despite efforts to engage all participants equally in the discussions, two to three participants seemed to dominate each focus group. This made it difficult to capture the thoughts and opinions of the less engaged participants. Additionally, because the study was designed around open-ended questions in an effort to extract more detailed participant-driven responses, answers to more basic questions (e.g.: Have you ever engaged in agriculture at a subsistence level? Have you ever engaged in

agriculture at a commercial level?) were sometimes left unanswered. I sometimes resorted to asking simple yes/no questions in an effort to capture this basic data, but was not always successful. If I were to re-design this study, I would start and end each focus group with a simple quantitative survey, the first capturing basic demographic information as well as thoughts and opinions about agriculture prior to being introduced to CEA, and the second capturing thoughts and opinions after being introduced to CEA. The surveys could provide baseline quantitative data representative of the entire group, and the data extracted during the focus groups could elaborate on and provide complexity to the quantitative data.

4. I was not prepared for the high level of interest some participants expressed in launching their own CEA endeavors. At the end of all three focus groups, some participants requested money, resources, or educational materials that may help them practice CEA, but I had nothing to give. I suggested finding additional information online, but it quickly became clear that none of the participants had the skills or internet access necessary to learn more about CEA online. If I were to conduct this study again, I would come prepared to leave behind at least basic self-help materials with step-by-step instructions on how to start a simple hydroponics operation.
5. Determining whether CEA-centered development initiatives would have local buy-in from the target demographic is only one step towards evaluating the potential effectiveness of such an endeavor. Any government departments, academic institutions, development organizations, or funders interested in pursuing such a project would need to take several more steps (see the *Implications* section above) before positive benefits could be realized in the real world.

I am deeply grateful to the focus group participants for sharing their thoughts, opinions, and personal stories with me. It took courage to share these thoughts, which were at times personal, controversial, or complex, with a stranger and in front of their peers. While it would be impossible to perfectly communicate every nuance of each focus group, I am confident that I have come as close as possible to accurately representing the overall sentiment of the discussions. I hope that the findings of this study can contribute in some small way to revitalizing the rural agriculture sector; increasing the amount of fresh, healthy food available in rural communities; and engaging young adults in the economy in meaningful ways in South Africa.

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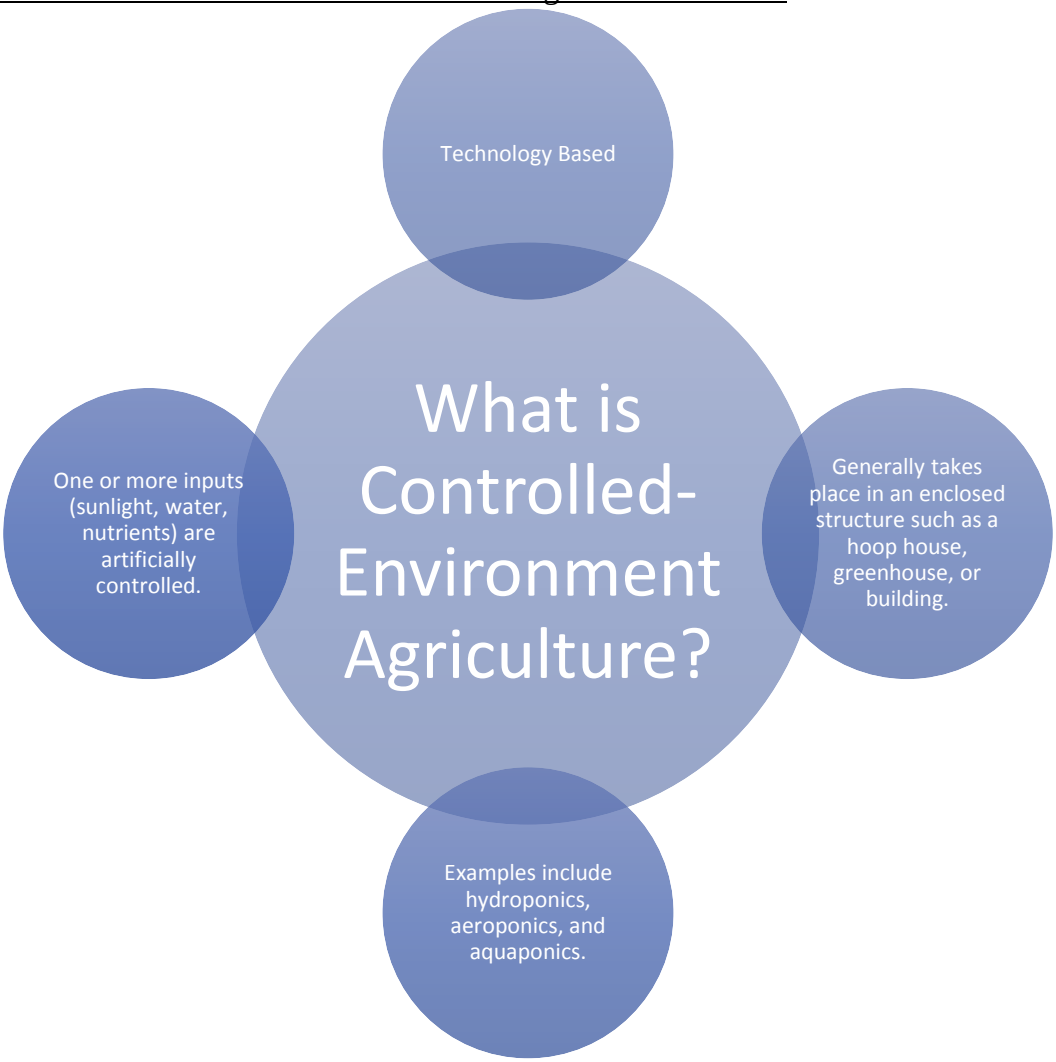
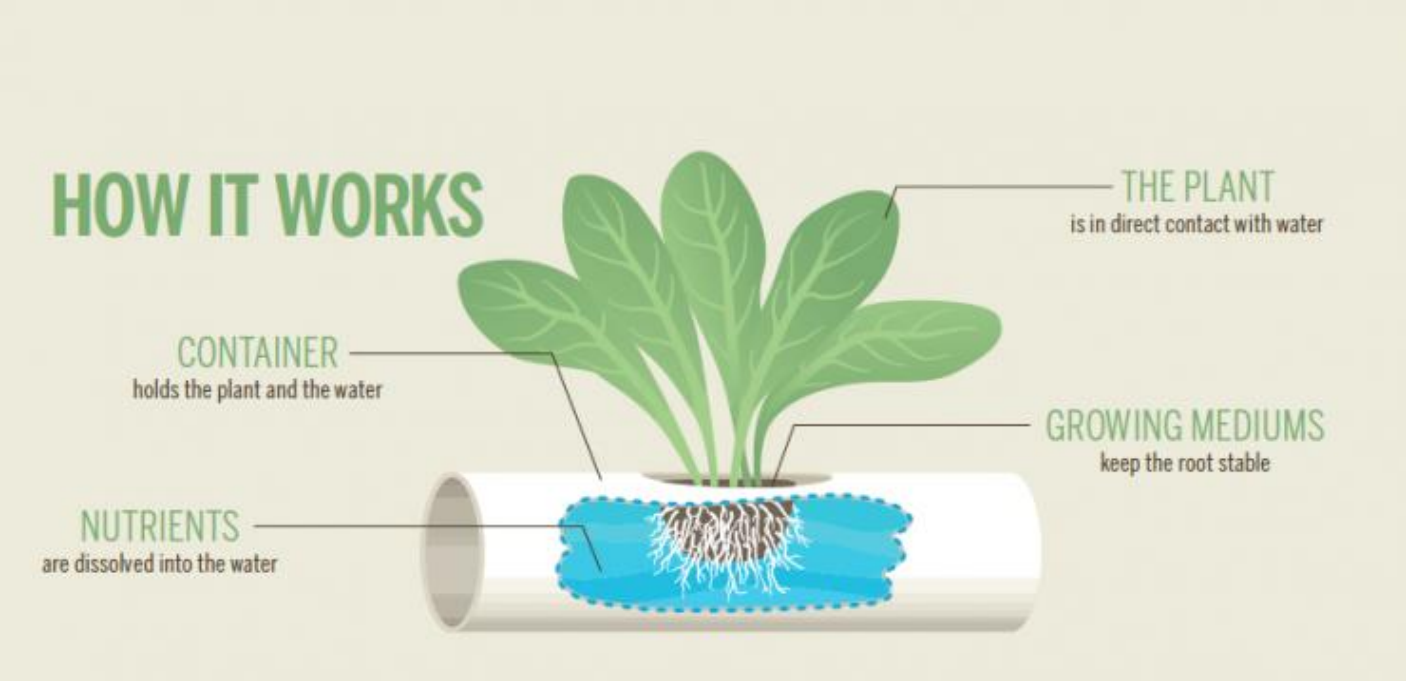
APPENDIX

Appendix A: What is Controlled-Environment Agriculture Handout



Appendix B: Basic Components of a Hydroponics System Handout

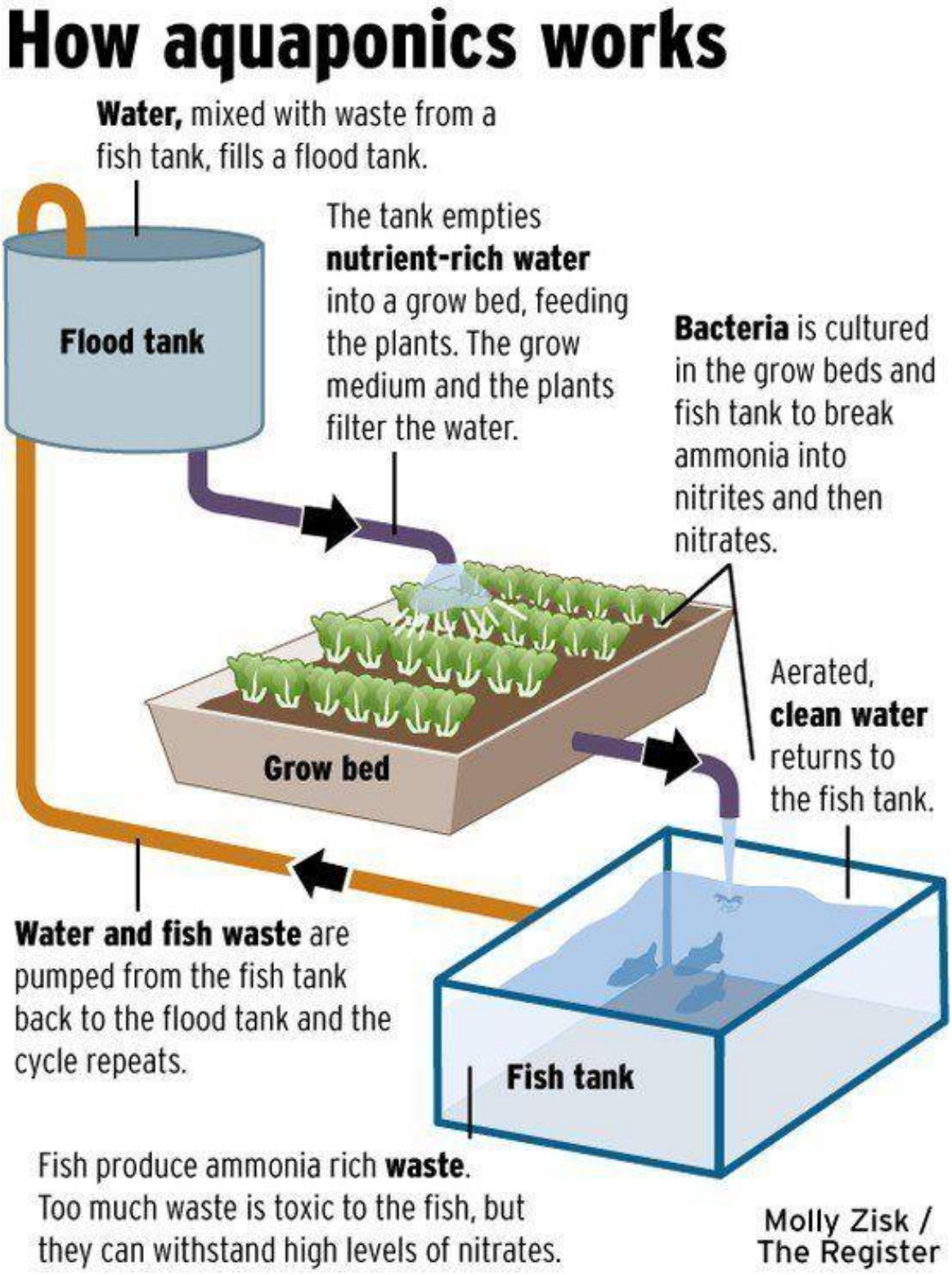


Plants sit in some kind of container so that the roots are submerged in (or sprayed with) water.

Nutrients (nitrogen, phosphorus, potassium, etc.) that would normally be taken in through the soil are manually added to the water in precise amounts.

The tops of the plants emerge from the top of the container in order to take in air and light, either from natural sunlight or artificial light.

Appendix C: Basic Components of an Aquaponics System Handout



Appendix D: Advantages of Controlled-Environment Agriculture Handout